THE

ENGINEERING MAGAZINE

VOL. XIV. JANUARY, 1898. No. 4.

THE POSSIBILITIES AND LIMITATIONS OF ELECTRIC TRACTION.

By Frank J. Sprague.

IN THE ENGINEERING MAGAZINE of July, 1895, I stated a few conclusions in reply to the query: "Will Trunk Lines be Operated by Electricity?" which were intended as a mild protest against the visionary predictions frequently made, often by men of more than local reputation, because of the remarkable achievements which have marked the advance of electrical science during the past decade. Since then a number of interesting articles have appeared on this subject, among others some in THE ENGINEERING MAGAZINE by Prof. Forbes and Mr. Charles Davis.

Beginning with the somewhat ambitious project of proposing plans for operating the Metropolitan Underground Railway of London, in 1882–3, I have frequently expressed publicly, and more often privately, certain conclusions as to the possibilities and limitations of electric traction, which, in view of many statements recently made, may, with advantage and possible profit, be restated and amplified, especially as they embody the result of more extended experience and maturer judgment, and also in view of my present connection with a radical departure in railway practice only recently declared of present impracticability.

It is not my intention to discuss from a statistical, or even detailed, engineering standpoint the many questions involved in this subject, or to make extended comment on the various articles which have appeared, although, while agreeing in some conclusions, I differ radically in others, but rather to point out, in as simple and direct a

Copyright, 1897, by John R. Dunlap.

manner as I may, a few pertinent facts as to present accomplishments and future probabilities.

No subject has been surrounded with more careless predictions or unthinking boasts than that of the application of electricity to trunk-line railway operation, unless it be the transmission of power from Niagara Falls, or the possibilities of inter-planetary communication.

The dynamo or motor, interchangeable terms for the same machine variously proportioned to meet the conditions of duty imposed upon it, has a modern useful life of scarcely a score of years. The use of this remarkable machine as a generator of electricity preceded in a commercial way its use to any wide extent as a motor; only thirteen years have passed since it began to have any standing for stationary-motor purposes, and it has been but nine years since the building of the Richmond and other pioneer electric railways gave the impetus to one of the most remarkable of modern industrial developments, which has afforded one of the main reasons for the glowing predictions of the future of electricity.

From the October, 1897 number of the *Street Railway Journal* I quote, from statistics presented by Mr. Clark, the following facts:

Out of 806 roads in the United States, 33 are operated by steam dummies (not including elevated railroads), 38 by cable, 167 by horses, and 698 by electricity. There are 145 miles of steam dummy track, 515 of cable, 1,010 of horse-car, and 13,580 of electric. There are only one-sixth as many horse cars as there were in 1888, a little more than twice as many cable cars, less steam dummies, and more than two hundred times as many electric cars, there being 37,097 as against 172 in 1888. The average length of the electric system is four and one-half times that of the steam dummy, a third greater than that of the cable, and three times that of the horse-car system.

It may well be asked:

What have been the causes of such an extension of railway activity? Are they the strange and all-powerful attributes of an unknown force, or the natural results of an intelligent and energetic effort to replace certain crude and costly methods of locomotion, tentative at best, and to enter into virgin fields because of ready adaptability to existing needs?

Bearing clearly in mind that electricity is, for the purpose of these remarks, simply a convenient and tractable agent for the practically-instantaneous transmission of power from one or more points to others, in any required amount and with any desired concentration, it was evident that the battle of the horse car and electric trolley was sure to end in an easy victory for the latter the moment it

could be intelligently and safely introduced, and apparatus could be made to meet the commercial requirements, for the advantages of lessened cost of power, greater speed, and increased capacity of units were all with the motor.

The cable,—despite certain limited advantages in some favored localities,—because of its great cost, fixity of speed, and localization of routes, is naturally following the horse car to the realms of the obsolescent.

Virgin fields opened up for new lines because of reasonable first cost, prospect of return on investment, and the many advantages offered by a rapid, clean, house-to-house service, and in these fields there has been no rival worth mentioning, despite the many futile efforts in behalf of gas and compressed-air motors.

Now, however, we have come to the consideration of the field occupied until recently almost exclusively by steam, and it may as well at once be realized that a modern giant is confronted, intrenched behind a complicated and an almost impregnable system of operation, which is the growth of years and the product of necessary conditions.

It has been said that "the throb of the locomotive is the heart-beat of civilization." I might paraphrase this, and say that the hum of the electric motor is a song of emancipation, but rather the emancipation of men and beasts, not of all steam apparatus, or at least not until fuel conditions shall make necessary the adoption of electricity and the utilization, even at increased cost over present practice, of waterfalls or tide-movements.

The term "trunk line" needs popular definition. It cannot be properly applied to all steam roads, but has a limitation defined by its very breadth. For the purpose of stating some conclusions, transportation lines may be divided as follows:

Street car or surface city and town lines;

Elevated or underground railroads;

Suburban lines;

Inter-urban lines,—the foregoing all devoted primarily to passenger traffic;

Independent steam lines;

Inter-connecting systems,—the last two handling both freight and passenger service.

A trunk line may be defined as a sort of main railway artery, with branch and connecting lines, terminal facilities, signal systems, in fact, all the varied equipment necessary for complete railroad operation, and used for carrying freight and passengers, both local and through, and with interchange of freight and passenger traffic and cars.

It will be immediately apparent to the most casual observer that the conditions surrounding the various services mentioned are in many particulars radically different, and the reasons which may make advisable, or even necessary, the adoption of electric traction in some cases might make it absolutely prohibitory in others.

Again, the problems involved in the substitution of power and alteration of traffic conditions on old lines are of an entirely different sort from those involved in the creation of new lines to meet existing or hoped-for conditions.

On the street-car question I shall touch only briefly. For this service some one of various electric applications,— the overhead trolley, the slotted conduit, the button system, and the storage battery, singly or in combination,—for they are all practical to-day under certain limitations, and according to the needs of each particular case,—will be used almost exclusively.

All elevated railways, despite the lamentable inertia of the great Manhattan system of New York, are ripe for electrical application, and one needs but to inspect the Liverpool Overhead Railway, the more extensive examples of the Metropolitan and Lake Street Elevateds of Chicago, the writer's most modern equipment of the South Side Elevated of the same city, now being changed from steam to electricity, the service of the Brooklyn Bridge, and the proposed changes on the Brooklyn and the Kings County Elevated Railroads, to make evident the near-coming end of steam-locomotive operation for this kind of service.

Of underground systems, the Metropolitan of London is destined to be changed by virtue of necessity; the City & South London Road has now been in operation for some time; the Central London Railway is under construction; and, as other extensive roads proposed in London, as well as that outlined by the Rapid Transit Commission of New York, all contemplate electric equipments, there remains no room for argument, nor has there been for a long time, as I have frequently pointed out, as to the utility of electricity for this class of service.

We have now to consider suburban lines, in which of course many extensions of street-car lines may be classed, and for which many new electrics have been built. New and old railroad systems must invariably be considered from a different standpoint, and at the moment I have in mind the general conception of a suburban line as that branch of a general railroad system which operates, wholly or in part, over the same tracks as the main-line trains or tracks contiguous thereto, is protected by the same signal system, uses the same or additional stations, is operated by the same class of equipment under

the usual steam conditions, and is subject to the established routine of steam-railway management.

Just here I may briefly state some well-settled facts in reference to the electric motor.

Its design and manufacture now present no particular difficulties. It can be built, singly or in combination, of any desired power per unit. It is reliable; it has a smoother torque than a locomotive, and can be worked for longer hours; it can be controlled automatically or at will, in one or more units, and by less skilled labor. Measured by car-miles, its depreciation is less. Its cost is reasonable, but will be still further reduced—although probably not very radically.

Again, power can be generated and distributed to any reasonable distance in any required amount and at well-known efficiencies, and with known elements of cost of installation, whether from a water or steam source of power. All this may be granted without question, because the facts are proven by that most practical of all tests, daily experience.

Until recently, although the possibilities of a different practice, having for certain work many advantages, have been pointed out frequently, there have been but two practical methods of using electric motors for railway purposes. One was the equipment of one or both axles of a car with motors controlling them from either end, making use in the last case of the full weight for rapid acceleration, and operating the car singly. The other was the construction of a special locomotive—as for example, that built for the Baltimore & Ohio Tunnel, or a locomotive passenger car on the general lines of one that I built in 1887, and as now used on the Metropolitan Elevated Railway of Chicago—to pull other unequipped cars or trailers, thus following the general lines of steam practice.

In 1887, in a paper read before the Society of Arts in Boston, I discussed the particular characteristics of the Third Avenue division of the New York Manhattan Elevated Railroad, and predicted the possibilities of fuel-saving, although the engines were already developing a horse-power hour for about six pounds of coal, and the cost of fuel was only six and one-half cents per train-mile. In addition, I particularly pointed out, although in an incomplete manner, certain advantages which would accrue by the distribution of the motive power, having a motor on every axle and having some method of simultaneous control of all motors, among these advantages being independent equipment, shortened time intervals, unlimited length of trains, high tractive and accelerative effort, reduced strains, smoother motion, etc.

The time was not ripe for so radical a departure,—it was even be-

fore the troublous days of Richmond,—but time and again I referred to the possibility of this sort of an equipment, and stated later that, "when motors reach their highest standard, every car can be made an individual unit, which can be operated in any combination and from any point of a train."

While not yet at the "highest" standard, the electric motor has reached such an excellence of manufacture and performance that this ideal, individualization of equipment of passenger cars, is now not only possible, but in many instances most advisable. Despite this fact, and although actually pointing out certain advantages by such an application, I find Mr. Davis declaring in somewhat positive fashion, as late as June, 1897, in THE ENGINEERING MAGAZINE, that "the system is not possible to-day," and thereafter basing a number of elaborate conclusions on a service at extraordinary speed between New York and Philadelphia upon a train system. I stated some years ago that, from a financial standpoint of investment and operation, a high-speed service between these cities was now a practical and commercial possibility, if the individualized system of car-equipment were adopted, and I have no reason to change the conclusion.

It is an interesting commentary upon the fallacy of negative prophecy concerning electric projects which do not propose to violate sound laws that, when Mr. Davis's statement was published, the writer was under personal contract with the South Side Elevated Railway of Chicago, then operating with an equipment of Baldwin compound 28-ton locomotives and standard passenger coaches, to equip 120 cars with an aggregate of 12,000 h. p. on an absolutely individualized system, using an average of 60 per cent. of the weight of each car, the contract specifying, as a condition, the ability to join cars in any desired number, sequence, or end relation, and to perfectly and equally control trains from either end of any car; that two cars were actually so operated on the 16th of July; that a public demonstration of the operation of a six-car train, so equipped, with a ten year-old boy at the operating lever, was made on the 26th of July in Schenectady,—the fiftieth anniversary of the first public exhibition of an electric motor operating a car made by the lamented Moses G. Farmer, in Dover, N. H.; and that on this very date public question of the practicability of such a system was made at the meeting of the American Institute of Electric Engineers by no less a scientist than Prof. Thomson.

Such a train has now for some time been in daily operation, its trips being intermingled with those of electric and steam locomotive trains, its official test has been accepted, and the change from

steam to electric operation will be made with the same cars and with both systems operated over the same tracks for a considerable period.

My own experience warrants me in predicting for this system, constituting as it does a radical departure from all previous practice, a future as important as that marked by the advent of the trolley, and suggests the further prediction that Chicago will be the Richmond of the new development.

Despite the many advantages which could be gained by the use of distributed motors, if the difficulties of simultaneous and complete control were overcome and what I have termed a "multiple-unit control were established," I did not fully realize all the possible results until I had the good fortune to be brought into contact with a remarkable series of investigations, embracing all the conditions of railway practice, made by Mr. John Lundie of Chicago, the consulting engineer of the Illinois Central Railroad, while considering the possibility of applying electricity to that road's suburban service; nor did I fully realize to its full the importance of a remarkably quick acceleration from the standpoints of economic power and transportation.

Mr. Lundie was the first engineer to bring out clearly, or even markedly, the fact that on suburban service, or any service requiring frequent stops at short intervals, any given schedule can be made most economically by attaining a very high rate of acceleration—unless interfering seriously with economic production; that, with given station stops, cost of equipment, established costs of coal and labor, and rate of depreciation, there is a rate acceleration coincident with a minimum cost of operation; and that, although the rate in the particular case of the Illinois Central is so great that it at first seemed almost startling,—amounting to forty miles in twenty seconds for an eighty-ton train,—and therefore involves an immense local current demand for a few seconds, such demand was perfectly permissible if the station was supplemented by a storage battery of high discharge capacity. It is safe to say that the future of the Illinois Central operations will warrant the very careful attention of both steam and electrical engineers and railway managers.

Touching briefly upon the question of suburban service, a few facts should be borne in mind. On competitive service particularly, with established routes and stations, traffic is affected primarily by rate of fare, frequency of service, and schedule-speed. A shortening in schedule time is of vastly more importance than any possible saving in power. The quicker the acceleration, the less the maximum speed required for any given schedule, and the less the amount thrown away in braking.

As the length of station intervals increases, the importance of rapid acceleration naturally decreases. The shortening of time at stations is vitally important on short-interval service, and hence provision for rapid loading and unloading of passengers is of great importance, for every second cut off from the running time between stations, with any given schedule, by station waits, increases the power-consumption and the required motor-capacity in a much greater ratio.

Since a multiple-unit system of control will enable suburban service to be operated with all the advantages briefly indicated, the displacement of the steam locomotive, in fact all locomotives, seems here assured.

The consideration of the larger problem involved in the application of electric power to trunk-railway service will be reserved for the February issue of THE ENGINEERING MAGAZINE.

SHIP-BUILDING AS A PRODUCTIVE INDUSTRY IN GREAT BRITAIN.

By James McKechnie.

II.—THE RECIPROCAL INFLUENCE OF PRIVATE ENTERPRISE AND NAVAL DOMINION.

IN my first article I sought to show the financial value to Britain of her ship-building industry from the labour, as well as the national, point of view; but there are also strategic considerations. It is largely because England has a ship-building, and therefore a shipping, industry that she needs a naval fleet; and the medium which creates the necessity insures the facility for meeting the need. The royal dock yards are admirable in every respect save capacity. You cannot put a quart into a pint pot. But I cannot deny myself the pleasure of referring to the splendid public services of the naval constructors and engineers who preside over these royal establishments, especially as they seldom receive honourable mention. On them depends more than is known to the public whom they serve, and only the ship-builder and engineer brought into contact with them can appraise their services. They are responsible for much public money, and spend it well. Portsmouth is the biggest of English yards, and the number of vessels launched during the past seven years has been twelve of 108,685 tons, while more than a million pounds sterling are spent in wages in a year, and seven hundred thousand pounds are disbursed for material. Mr. J. A. Yates is the chief constructor, and Mr. John T. Corner the chief engineer. Chatham comes next in importance; there the seven years' total is eleven vessels of 94,530 tons, while one million sterling is spent annually on wages and material. As at Portsmouth, three battle-ships and three cruisers may be simultaneously in process of construction, although the maximum is seldom reached. Mr. W. James is the chief constructor, and Mr. W. G. Littlejohns the chief engineer. From Devonport, which promises, with the addition of Keyham, to be an enormous establishment, there have been launched in seven years sixteen vessels of 52,500 tons. There more than half a million per annum is spent well, Mr. H. R. Champness being chief constructor and Mr. R. Mayston chief engineer. At Pembroke, where in seven years eight vessels of 67,915 tons have been launched, Mr. H. Cock is chief constructor, while at Sheerness the offices are filled respectively by Mr. H. H. Ash and Mr. R. H. Andrews. It is also well to

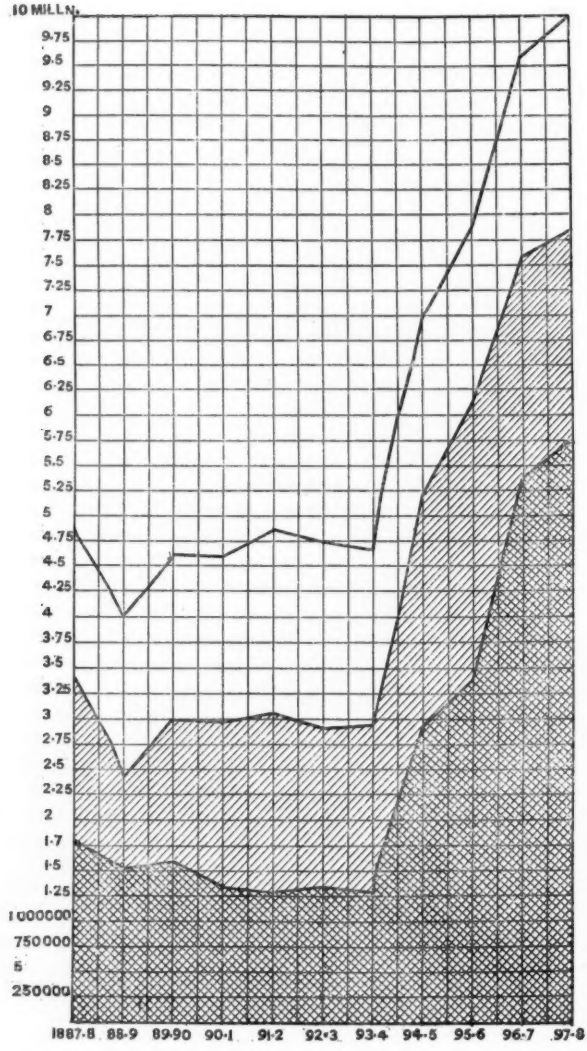


DIAGRAM SHOWING DISBURSEMENT AND DISTRIBUTION OF MONEY FOR NAVAL CONSTRUCTION.

speak of the inspectors of machinery, who are important officials from the national point of view, for, should their vigilance relax, danger might be discovered only in the hour of peril. Messrs. H. J. Oram, J. Wooton, C. B., J. A. Bedbrook, and J. J. Finch are men well tried in the profession, and on their judgment full reliance may be placed.

These royal yards are conveniently situated from the strategic standpoint, no matter by what power England may be opposed; but there is a wide extent of coast without any government establishment, and here the private works, because of their wide distribution, will be of immense value. I have prepared a diagram which shows at a glance the money disbursed for new construction, including guns, for the navy, and the division of it between (1) contractors for ships and engines, (2) firms supplying material for ships, etc., built in the dock yard, and (3) laborers in the royal dock yards. This shows in a striking manner the great activity in war-ship-building in recent years. The cross-hatching shows the money spent for private ship-building and engineering firms, approximately one-half of the total; the section-lining the expenditure on material; the remainder the wages paid in the royal yard. It might easily be reckoned that the establishments capable of doing thoroughly reliable work have double the capacity of the dock yards, alike for construction and for repairs. The strategical value is, therefore, great, for, as I have already contended, victory will ultimately rest, not so much with the nation which may gain the first advantage, as with the one having the greatest recuperative powers. Sir William H. White, who is unquestionably the best and, I will add, a scrupulously accurate authority, says England can build so much faster than other nations that he can afford to wait until he sees their designs before proceeding with his work, and yet have his improved ship ready first. The same applies to repair work.

The docking facilities afforded round the coast, principally by or as a result of ship-builders' energy, add materially to the value from the strategical standpoint. In the map of the British Isles on page 565 I have shown at the various centers the number and size of the docks suitable for warships. Battle-ship docks are shown within the boundary line by a plan in black, large cruisers by a plan in white, and second-class cruisers by a striped plan. These do not by any means represent the total number of docks. In all, two hundred and forty-eight might have been indicated; many of them are of great length, but have unfortunately too little depth of water on the entrance sill. Thus, for instance, in some of the merchant shipping centers there are docks six hundred feet long with only twenty-

two feet of water on the entrance sill. Such must obviously be classed as for second-class cruisers drawing from 16 to 20 feet. There is a typical case at the James Watt dock in Greenock, where the length is 535 feet with a draught of only 20 feet on the sill and a width of 60½ feet. This may suit modern steamers, which are docked when light, but not warships, whose width and depth are the limiting dimensions. Length of ship is restricted, in order to reduce the target and the length of armoured area; to minimise draught for a given weight, great beam is necessary. Thus 75 and 76 feet beam and 25 to 27 feet draught have to be reckoned with. I have shown battle-ship docks in black and large-cruiser docks in white; but the latter may in most cases be used for battle-ships, although some of the battle-ship docks are too short for big cruisers. Many of these docks belong to ship-builders, and, as a rule, repair-facilities are at hand. There are few navigating difficulties, except at the Bristol channel, where the range of tide is, say, at Barry 28 feet; it is subject for expert consideration whether the current might not involve danger and make the few docks of the channel of doubtful utility for heavy ships. But there are, in any case, sufficient facilities well distributed around the British coast for docking one hundred cruisers and about forty-five battle-ships, or large cruisers. The remaining one hundred odd docks would be suitable for small craft, gunboats, and destroyers. In some cases the docks would accommodate two vessels, one abaft the other.

And now as to the war-ship-building capacity of private yards. Most sanguine estimates, I know, have been made—in some cases without even reference to the number of building-berths. It is idle to assume that in the hour of need every firm will have all their best berths vacant, and, when it is remembered that a weight of six thousand tons has to be supported on a small area, before and up to the time of launching, it will be understood that any ground will not suffice, while on the Clyde and Tyne the launching-water area is restricted in the case of some of the berths. Again, experience, alike on the part of the management and the men, is necessary to build a big cruiser or battle-ship. This cannot be acquired in a day; consequently I have included only firms that have done heavy work. Their task is made so easy by the skill and forethought of Sir William White, the director of naval construction, and Sir John Durston, the engineer-in-chief, that the firms may be depended upon for much. I have taken these points into consideration in filling in, upon the map, a sketch of the fleets which might be created at each port in two years or even less. Battle-ships are shown with one funnel, first-class cruisers with four funnels, second-class cruisers with three

THE SHIP-BUILDING AND DOCKING FACILITIES OF BRITAIN.

MAP SHOWING DOCKS FOR WARSHIPS, AND LARGE WARSHIPS THAT MAY BE BUILT IN 2 YEARS

DOCKS DRAWN ⬮ ARE FOR BATTLESHIPS, ⬭ FOR LARGE CRUISERS, ◯ FOR 2ND CLASS CRUISERS

SHIPS BUILT IN 2 YEARS ▭ = BATTLESHIPS, ▭ = 1ST CLASS CRUISERS, ▭ = 2ND CLASS CRUISERS

funnels. Needless to say, their scale is a trifle larger than the scale of the map. I have not included small craft, of which a large fleet might simultaneously be constructed. Each district, too, would give some help to the government yards in providing the engines. I think the readers in other lands than Britain will agree that the map proves the greatness of the British ship-building industry.

In preparing this map, I have had help from the three hundred odd pages of the navy estimates, which always yield a wealth of suggestive data. The cynic may say that that is why the accountants make it so obscure; even so, gold is always hardly won. From this mass and other sources I have gathered many interesting facts, and especially the amount of money distributed to each district and firm for modern war-ships. With the view of investigating what I might term the migration of industry, I have separated the receipts of the various districts into three periods: (1) the years preceding the naval defence act; (2) the years included in its operation; (3) the years subsequent to it. It is not a very unequal division, owing to recent activity, and the ships included are only those on the list of serviceable vessels. The first period accounts for nearly nineteen millions' sterling of contract work; the second for more than ten millions; and the third for nearly eighteen millions. This takes no account of dock-yard work or the material required for it; but it includes propelling machinery for dock-yard ships.

The most striking point of the analysis is the decadence of ship-building in London. In the first period more than half of the naval money voted to contractors was disbursed in the metropolis; under the naval defence act it dropped to less than one-fifth; in the third period it is only 15 to 16 per cent. Instead of securing nine millions' sterling for naval purposes, as it would have done had the proportion in the third period been the same as in the first, London received only about three millions, including torpedo-boat destroyers. The Clyde has increased her share greatly. In the first period she received 26.6 per cent.; in the second practically the same; in the current period 39.2 per cent. The general tendency on the Tyne is not so clearly defined. Two considerations account for this. Elswick has lately done little for the British admiralty, preferring the work of other governments, which allows them to supply the guns direct. Palmer's Company, in the naval-defence-act period, had two battle-ships which have no counterpart in the current period. Thus the ratios in the three periods vary,—15, 28.8, and 8.3 per cent. respectively. The Mersey has also improved its position, but this is due entirely to the ever-successful efforts of the old firm of Messrs. Laird Brothers. They are almost alone as representatives of the

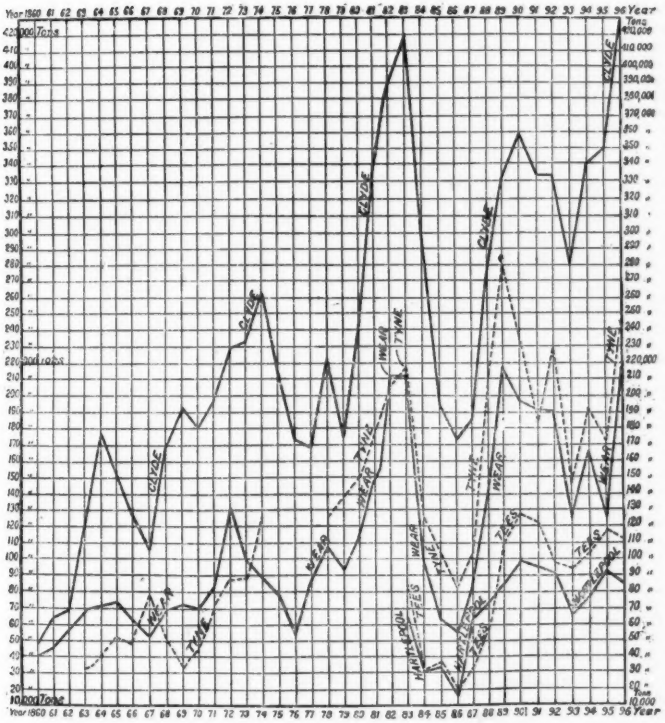


DIAGRAM OF PRODUCTION OF NEW SHIPPING IN PRINCIPAL PORTS OF UNITED KINGDOM.

The horizontal lines each represent 10,000 tons and each vertical line a year. Reliable statistics are not available for the Tyne for all years prior to 1878.

industry. In the first period they had 1.27 per cent., in the second 10 per cent., and in the current period 13.65 per cent. Hull, like the Tyne, has varied; it had considerable work under the naval defence act, getting 8.8 per cent. of the total spent on contract work, while in the preceding period it had only 3.09, and in the current period 3.42 per cent. Mr. Seaton's energy obviously is not relaxed.

Peculiarly satisfactory is the position of Barrow, where there is only one works—owned by Messrs. Vickers, Sons & Maxim, Limited. Prior to 1889 there was earned only a quarter of a million sterling, but under the naval defence act, a much shorter period, nearly three times that was received, or 6.7 per cent. for the kingdom, while in

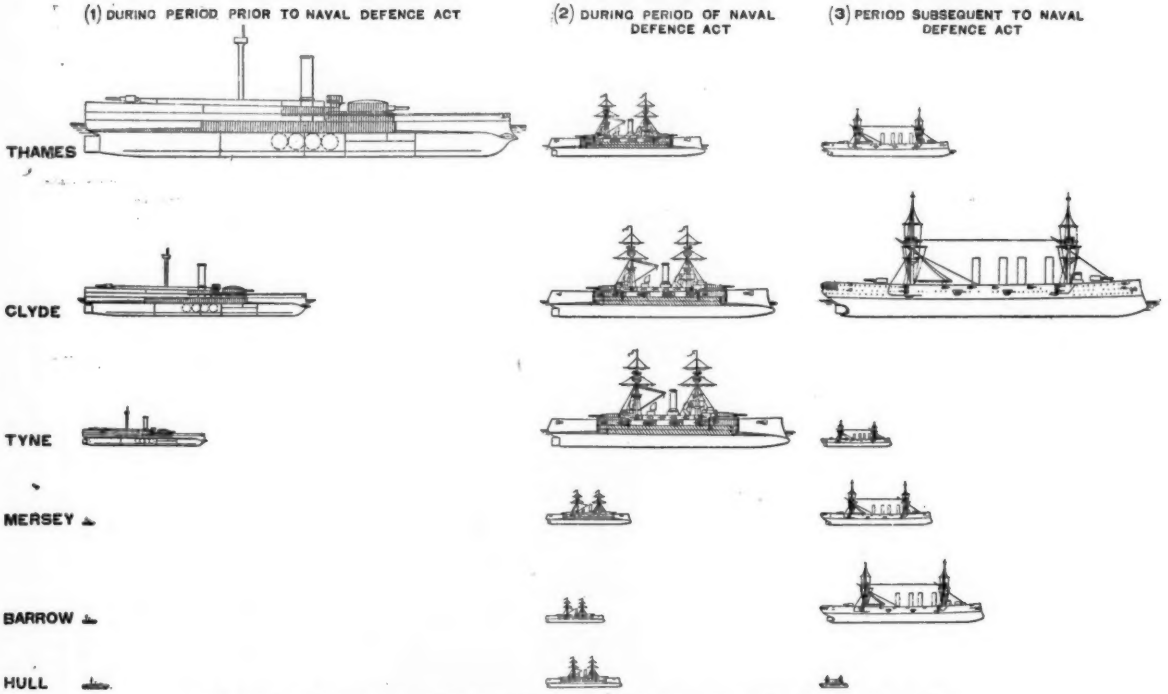
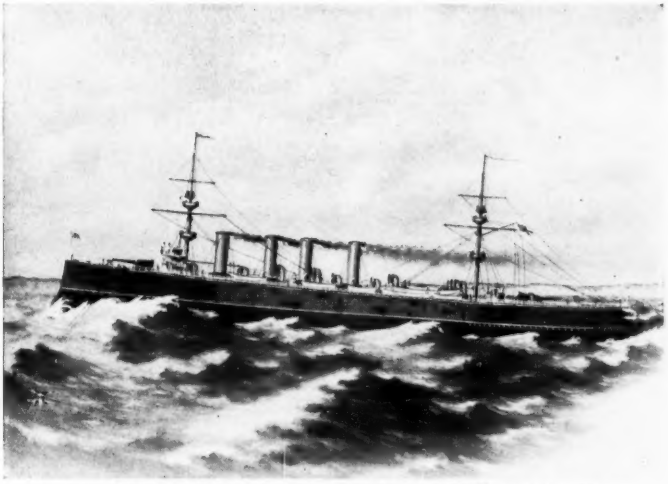


DIAGRAM SHOWING DISTRIBUTION OF MONEY FOR NAVY-CONTRACT WORK IN THREE PERIODS.

It will be seen that in the first period the Thames took twice as much as the Clyde, but in the second period only two-thirds as much as the Clyde or the Tyne. In the third period the Clyde takes four-fifths of the total, and more than double the Thames. The progress of Barrow is most marked. The proportion in each case is denoted by the length of the ship.

the current period the total was more than £3,500,000 sterling, or nearly 20 per cent. of the amount distributed to contractors throughout the kingdom. The influence of the late Mr. Bryce Douglas, and especially of Mr. Alexander Adamson, the present managing director, is clearly traceable here.

I have shown diagrammatically the position in the several districts. The first period is represented by an old type of battle-ship; the other two periods are represented by modern creations,—the Magnificent and the Powerful. The diagram will be readily understood. The size of the ships, reading downwards, shows the relation of one district to the other, and, reading across the page, the growth



THE NEW FIRST CLASS BRITISH CRUISER "NIOBE," 11,000 TONS.
Built by Vickers, Sons & Maxim, Barrow-in-Furness.

or decline, in the three periods, of each district. Thus the growth in the case of the Clyde and Barrow is seen at a glance.

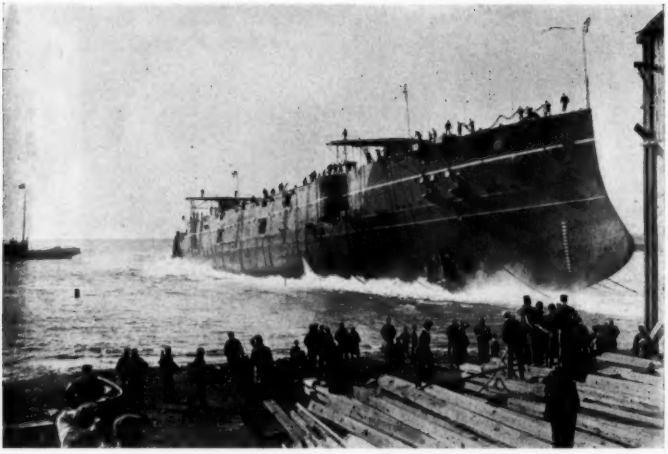
If the figures for individual firms be taken separately, it is found that in the latest of the three periods the Naval Construction Works at Barrow occupy first place. Since 1893 the admiralty have entrusted this firm with vessels whose aggregate value, excluding guns, amounts to a little more than £3,500,000 sterling. These include every type; the first class battle-ship, "Vengeance;" the 14,300-ton cruiser, "Powerful;" two 11,000-ton cruisers, "Niobe" and "Amphitrite;" the 5,600-ton cruisers, "Juno" and "Doris;" and several 30-knot destroyers,—an aggregate tonnage of 62,345 and

a collective power of 140,200 i. h. p. These figures are suggestive of many problems in boiler, engine, and propeller design. The record, of which the management may be proud, largely explains the purchase of the works by the famous armour- and gun-makers, Vickers Sons & Company, Limited, Sheffield. The combination, especially as it includes the works of the Maxim-Nordenfelt Gun and Ammunition Company, must have far-reaching effects, as it enables the company to construct any ship of war without outside help, they themselves supplying constructive material (including armour, forgings,

FITTING-OUT DOCK AT NAVAL CONSTRUCTION WORKS OF VICKERS, SONS & MAXIM. H. M. S. "Doris," "Powerful" and "Juno" at the 100-ton crane.

and castings), guns, with mountings and ammunition, and electric gear for all purposes. The influence in the direction of economy and speed of construction can scarcely be exaggerated, especially under a chief who, in America, would be styled a king of mechanics; it is only a suggestion of greatness that he is best known in England by his company as Mr. Tom Vickers. It is an open secret that the aim is to compete not only for every type of British, but also for foreign, war-ship work. In the latter case armour, armament, ammunition, and all stores are included in the one specification; in contracts for British ships these items are separate.

THE NAVAL CONSTRUCTION WORKS OF VICKERS, SONS & MAXIM, LTD., BARROW-IN-FURNESS.



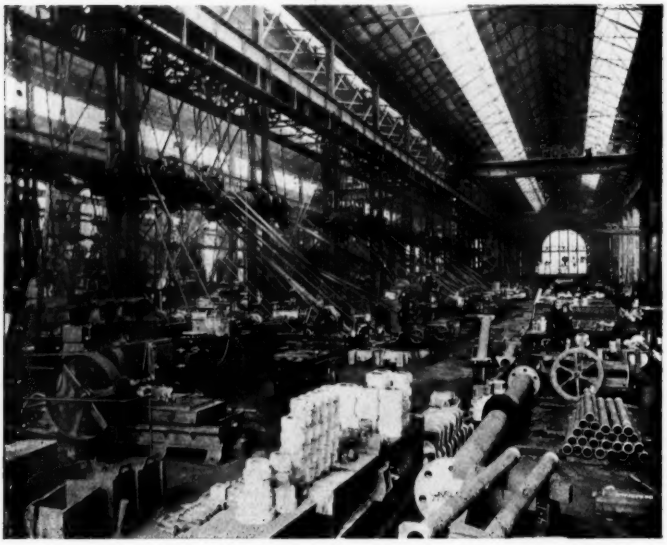
LAUNCH OF H. M S. "NIOBE."

VIEW IN MACHINE SHOP OF VICKERS, SONS & MAXIM, WITH WALL-PLANING MACHINE WORKING PHOSPHOR-BRONZE STERN FRAME FOR H. M. S. "NIOBE."

The counterpart of this Vickers' combination is found perhaps more in Krupp, of Germany, than in Sir W. G. Armstrong, Whitworth & Co., but the Germania Ship-building Establishment of the Krupp Company has not the reputation or the facilities of the Barrow works, while the Armstrong-Whitworth Amalgamation, although the Elswick yard (organized originally by Sir William White before he became director of naval construction) is admirably equipped, is yet without marine engineering works. This may be remedied;

ENGINE-FITTING SHOP AND ENGINE-ERECTING PITS, VICKERS, SONS & MAXIM.

already there are expectations of its taking over the Wallsend Engineering Works, now under the direct management of Mr. Andrew Laing, formerly of Fairfield. He, with characteristic energy, has reconstructed them, and is building his first set of destroyers' engines there for Elswick; but against this view there is the long association between Lord Armstrong's company and Humphreys Tennant & Co., the famous London engineers who have for so long engined Elswick warships, and have a splendid shop—probably the best in London. The disadvantage, however, of building engines in London for ships



VIEW IN THE ENGINE SHOP, VICKERS SONS & MAXIM.

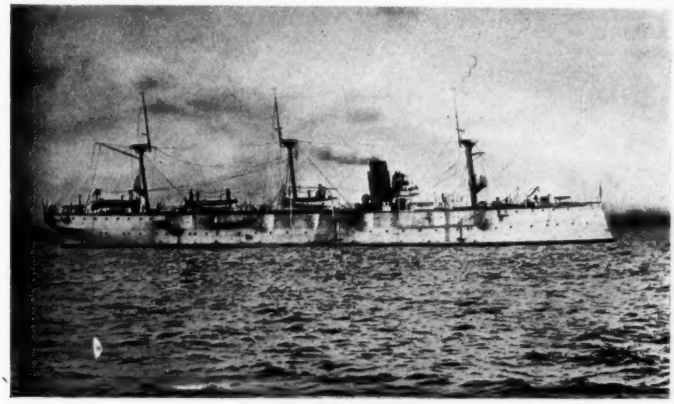
constructed and completed at Newcastle, two hundred and fifty miles distant, need only be suggested to be appreciated. In any case both the Vickers and the Armstrong-Whitworth combinations must be powerful factors in maintaining the supremacy of British naval ship-building against the best competitors in the world, and it is not improbable that even the British government may find it economical and efficient to give in the one contract an order for a ship ready for action, after the policy which, as already indicated, is frequently pursued by other governments, and thus utilize the benefits of concentration of management.

Elswick, where Captain Noble and Mr. F. Watts are important factors in success, has devoted most attention to foreign work; in recent years it has had a splendid record, but I cannot enter into an analysis of the ships, as I am concerned here only with the advantage of Britain's ship-building industry to her naval supremacy. The Clydebank works, to which I referred in my previous article, have had a long series of successes. Indeed, the analysis of the competition of the British fleet of to-day shows that this company, among contractors, received the largest amount of money, its connection extending over a longer period than that of most of the other firms.

It has taken, in all, about £5,750,000 sterling. Its naval-defence-act contributions included a battle-ship and three second-class cruisers, with engines for others; since then it has secured work amounting to £3,400,000 sterling.

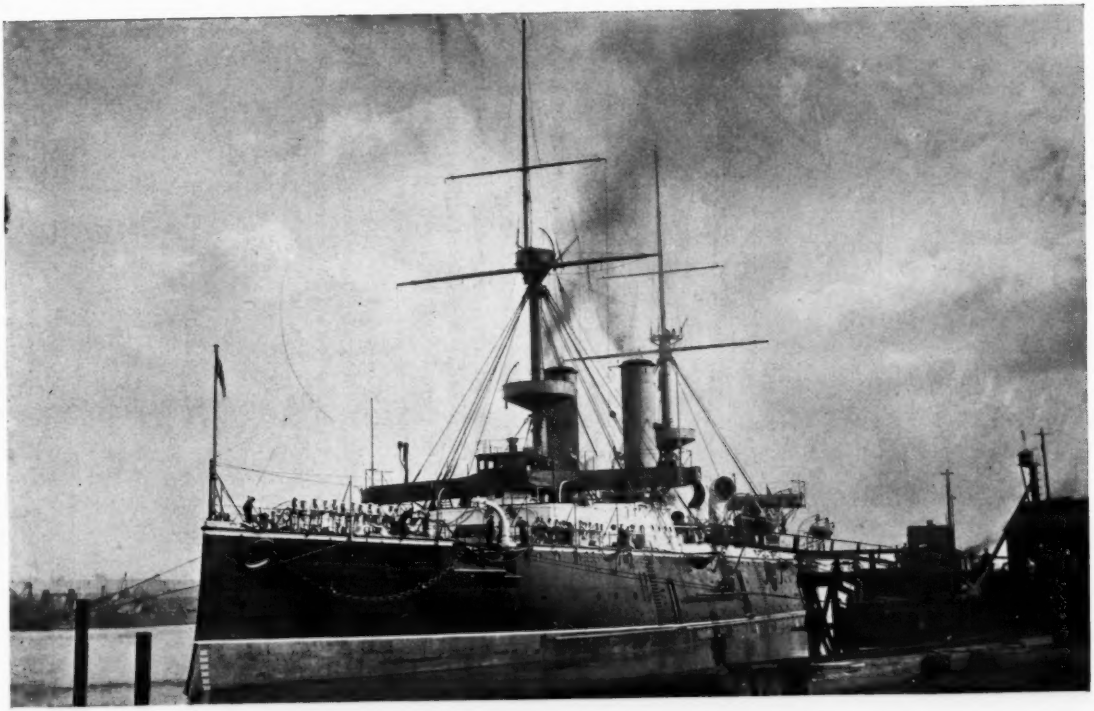
The Fairfield Company, of which Dr. F. Elgar is a director and Mr. Edmund Sharer and Mr. Alex. Gracie are departmental managers, is also taking a prominent place. It engined only three vessels for the naval-defence-act fleet, but in recent years has had orders for work valued at more than £2,500,000 sterling. This includes two cruisers of 11,000 tons, to steam 20½ knots, similar to vessels built at Barrow and Clydebank, and also four 5,600-ton-cruisers. Although perhaps superfluous, it should be stated that British firms secure orders purely upon financial considerations,—their ability to complete them having been previously determined,—and it is commendation of the fulness and definiteness of specifications, and also of the great experience of the three firms, that the tenders sent in by the Barrow, Clydebank, and Fairfield establishments for the Amphitrite, Ariadne, and Argonaut, respectively, showed a difference between top and bottom prices of barely 0.5 per cent. of the total. True, each had one similar vessel under order, but not at a stage where accurate costs could be worked out. There was no collusion; that I can guarantee. The spirit of friendly rivalry is too great.

To Messrs. Laird's position I have already referred. The Palmer Shipbuilding Co., whose departmental managers are Mr. J. W. Reed and Mr. J. Dugdale, with Mr. J. P. Wilson as technical adviser, has built only two small cruisers and a fleet of destroyers; but the re-

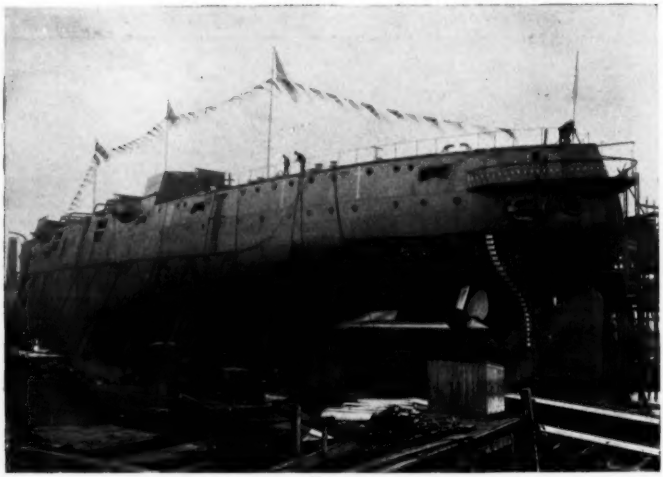


A JAPANESE CRUISER.
Built by the Clydebank Shipbuilding and Engineering Co., Ltd.

BIRDS'S-EYE VIEW OF PALMER'S SHIPBUILDING AND IRON CO., LTD., JARROW-ON-TYNE.



H. M. FIRST CLASS BATTLE SHIP "REVENGE" ALONGSIDE THE JETTY.
Built by Palmer's Shipbuilding and Iron Co., Ltd., Jarrow-on-Tyne.



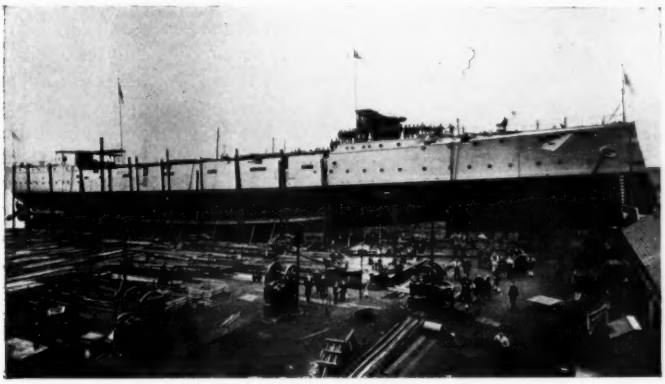
H. M. S. "REVENGE," READY FOR LAUNCHING.
Built by Palmer's Shipbuilding and Iron Co., Ltd.

sources of their establishment are reflected by the fact that they netted a larger share of the naval-defence-act contract sum than did any other firm, and in all have taken nearly five millions for the fleet as it stands to-day. Messrs. Napier, of Glasgow, have in recent years preferred merchant work, but they have a long and highly creditable record. A historical interest, too, attaches to their establishment, for there Robert Napier built his first marine engine in 1824, and the machinery for all the Cunard steamers built between 1840 and 1860. It indicates the change in methods to state that the drawings for most of these were made after the engines were built, each component part being formed and pieced together as convenience directed. The foreman at some of these historical jobs was David Elder, father of John Elder, founder of the Fairfield Works. From Napier's many of the earlier battle-ships came, and it was here, too, that Dr. A. C. Kirk perfected the triple-compound marine engine, and made the first set of this type for the navy. The concern is now as briskly carried on as it was in past years by Messrs. John & James Hamilton and a descendant, although not in direct line, of the original stock, Mr. James Napier. In juxtaposition is the yard of the London and Glasgow Co., which has done important government work since taken in charge by Mr. J. W. Shepherd, formerly of Fairfield. On the Clyde, too, Messrs. Caird have done sufficiently heavy work to amply justify dependence upon them in an

TORPEDO-BOAT DESTROYER "WHITING" STEAMING 31.3 KNOTS.
Built by Palmer's Shipbuilding and Iron Co., Ltd., Jarrow-on-Tyne.

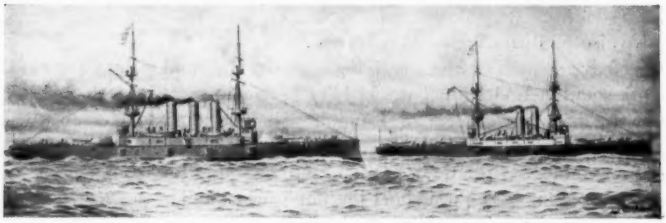
emergency, while Messrs. Scott, although their recent naval work has been confined to the construction of engines for dock-yard ships, have also facilities for building cruisers.

I have spoken of the great decrease in the total money for naval work spent in London; it would have been still more remarkable, had not the marine engineers of London still held their own against the firms in the north. Humphreys, Maudsleys, and Penn still supply most of the engines for the dock-yard ships; geographically they have some advantage, for it is but a short journey down the Thames to Chatham and Sheerness, and a comparatively short sea-trip to Portsmouth, Dev-



H. M. S. "PIQUE," READY FOR LAUNCHING.
Built by Palmer's Shipbuilding and Iron Co., Ltd.

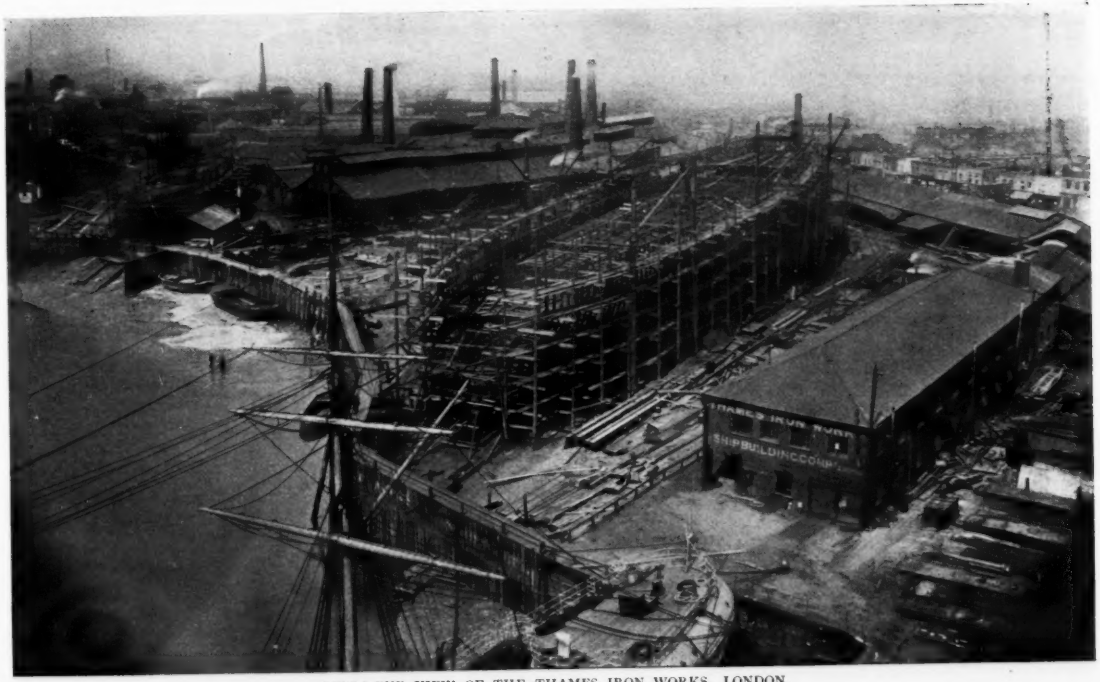
onport, or even Pembroke, while the heavy forgings and castings come from the midlands of England,—a few of them from Scotland,—so that they can be as cheaply sent to London as to the Tyne or the Clyde. Higher wages and rent is the difficulty, and the firms are more and more feeling the pinch of competition. Hawthorn, Leslie & Co., of Newcastle, Scott, of Greenock, and other firms, have undertaken the contract for the engines of several recent dock-yard ships. That London gets most of its money for engines rather than ships could easily be shown. There is a decrease in the number of ship-building firms in the metropolis. I cannot recall a firm engaged in war-ship-work in any district twenty years ago which has not maintained its full vigour to-day, except in London. The Thames Iron Works, where the first British iron-clad—the old "Warrior"—was built, was for a time threatened, but, nurtured by Mr. A. F. Hill with great devotion, it still is an important item in the naval ship-building of Britain. It has a British and a Japanese battle-ship on the stocks, and only recently



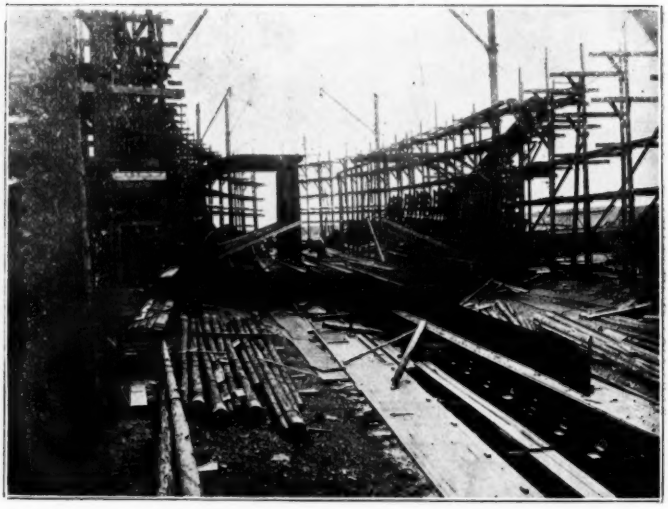
I. J. B. "SHIKISHIMA" AND H. M. S. "ALBION" AS THEY WILL APPEAR COMPLETED.
Now under construction by the Thames Iron Works and Shipbuilding Co., Ltd., London.

completed the Fuji for the island kingdom of the east. Samudas, Rennies, Ravenhills, and Millwall Iron Works are only memories.

Yarrow and Thornycroft have widened their repute and their influence, if that were possible. The great development in torpedo tactics is traceable to them. The flash of the "Lightning" upon the scene startled European powers to the full possibilities. Since then almost every year has been marked by a forward movement, until now high authorities, like Admiral Colomb, seriously discuss whether or not the whole game of sea-warfare has not been radically changed, and the battleship made as useless as the old galleys of the Roman empire. There is much in it, too. For the price of a battle-ship fifteen or eighteen of these 30-knot destroyers can be built, and they can be manned by the crew of one battle-ship. Such a force attacking a ship, even in broad daylight, would make things lively. I have not recorded on the map the facility for constructing these craft. Twelve yards have laid themselves out for the work of building them, and it must be



BIRDS-EYE VIEW OF THE THAMES IRON WORKS, LONDON.



I. J. B. "SHIKISHIMA" IN COURSE OF CONSTRUCTION AT THE THAMES IRON WORKS.

remembered that, while in all other cases the admiralty submit drawings for hulls, the builders are themselves responsible for design and speed of these craft. Immense difficulties are involved, if there is not some experience to draw upon. Nearly one hundred of these vessels have been, or are being, constructed, and a large number could be built within a year, should the occasion arise. Had this work of building a new type of craft been demanded in any other country, speed premiums would have been almost necessary, but these are unknown in Britain. In the United States, on the other hand, much has been earned in this way. I have taken seventeen vessels at random, and find that the power and speed premiums equalled 7.85 per cent. of the total cost; in one case it was 25 per cent., in others from 10 to 12 per cent. It is all the other way in England; firms compete keenly for government work, for it carries a prestige. The approval of the admiralty experts creates a standard which other governments are ready to accept, and the foreign war-ship built in Britain is none the worse for that.

FUTURE SUPREMACY IN THE IRON MARKETS OF THE WORLD.

By J. Stephen Jeans.

III.—ADVANTAGES IN POINT OF CRUDE MATERIALS.

IT needs no argument, or parade of figures, to make clear the fact that the nation that can produce the cheapest pig iron is likely, all other things being approximately equal, to be able to secure the leading position as a manufacturing country. The production of cheap pig iron involves and implies the production of an ample supply of cheap coal, the command of abundant resources in reasonably cheap iron ore, efficient mechanical equipment, and last, but not least, relatively economical, though not necessarily low-paid, labour. The command of cheap pig iron carries with it the command of cheap materials of construction generally, cheap ships, cheap railways, cheap buildings, cheap tools, and cheap implements of husbandry; and these, again, mean cheap transport by land and sea, cheap food, cheap dwellings, and the command of material comforts generally at a relatively low price. Of course, it will be understood that I use the word cheap in its ordinary signification of relatively low priced, and that I assume that, apart from a low cost for iron, all of the conditions are approximately equal.

It will be understood, moreover, that all other conditions are not now, and probably, in the nature of things, never can be, quite the same. Accidents count for a great deal in the history and destinies of nations. A recent writer has pointed out that "the accident of position has thrust a relatively insignificant people into the leadership of a world-wide commerce and the government of the world's greatest empire." The location of Great Britain has had much to do, and probably always will have a great deal to do, with her industrial status. But it is now recognized as a fact of much significance that location has ceased to possess dominating importance, and that annihilation of distance by modern inventions may bring up a country of less apparently supreme resources to the level of Great Britain, with its advantages of unique geographical and maritime supremacy.

One of the most striking and perplexing features that are at once presented in any attempt to estimate the comparative economic circumstances of different countries is due to the rapidity with which changes have already occurred, and are now actually occurring, in the industrial world. No one, for example, would have believed it possible, only twenty years ago, that the conditions of our iron and

steel industries would in the interval have witnessed the revolution that has actually taken place; that Great Britain would have come to depend on foreign ore-supplies to the extent of nearly one-third of her total consumption; that Germany would have attained, by the accident of the discovery of the basic process, a commanding position in the iron industry of Europe, and would have reached a larger export of finished iron and steel than Great Britain; that steel would have taken the place of wrought iron to the extent that it has; that the open-hearth steel process would largely have displaced the bessemer, and that railway material would have ceased to hold the commanding position that it then did; and that the United States, of all countries, could have produced finished iron and steel as cheaply as they are produced in Great Britain, over a wide area of operations, and more cheaply over a more limited area. Equally incredible would have appeared prophecies at that time as to what would ultimately be achieved in the way of output from a given plant. The man would have been scoffed at who should have spoken of producing 600 tons a day from a single blast furnace; of raising 64-per cent. ore for sixpence a ton; of an output of 100,000 tons of bessemer steel a year from a pair of vessels, or of 15,000 tons a year from a single open-hearth furnace; of an output of 200 tons of wire rods from one mill in a shift of eleven hours; of using pressure of 12 and 15 lbs. of blast; of ninety cent coke delivered to furnaces at little more than a dollar; of labour at blast furnaces being brought down to about 2s. per ton of pig; and of many other matters, equally wonderful and unexpected, that have come to pass during the interval. It is, nevertheless, the fact that to some extent "coming events cast their shadows before," and we may haply succeed in measuring those shadows, and divining their portents, if we take some pains to make ourselves acquainted with the first principles of industrial success and supremacy.

The most remarkable feature of the industrial revolution that has already so largely altered the conditions of manufacturing industry on two continents, and threatens to do so to a still larger extent in the future, is the reduction that has taken place in the cost of transport. Exactly twenty years ago, Lowthian Bell showed that the cost then of transporting to Pittsburg the raw materials required for the production of a ton of pig iron was £1.15.3 ($8.51), while the corresponding cost to Cleveland (Ohio) was £1.16.0 ($8.75); to Lake Champlain, £1.5.6 ($6.20); to the Lehigh Valley, £1.1.2 ($5.15); to Chicago, £2.6.6 ($11.30); and to West Virginia, £0.16.0 ($3.89). These are to-day the leading iron-producing districts in the United States, excepting Alabama, where the then cost of assembling the raw materials per ton of pig was 9s. 6d. ($2.31). It need hardly be pointed

out that these costs were then much in excess of the corresponding costs in Great Britain. Not only so, but at that time the cost of the materials was relatively very high. Bell gives the then selling price, at the mines, of Lake Superior ore as 15s. to 17s. per ton; of the Cornwall ores as 11s. 6d. to 14s. per ton; and of Alabama ore as 7s. 6d. This old order has now entirely changed, yielding place to new. The low cost at which ores are carried from the various ranges in the Lake Superior region to Pittsburg, Cleveland, and Chicago, is one of the marvels of American economic progress, and hardly less remarkable are the reductions that have taken place in the transport of fuel from the Connellsville coal-field to Chicago and other points of consumption. In continental countries the relative costs of transport are not nearly so low as in the United States, and in Great Britain they are the highest of all, though this fact is largely compensated by the closer proximity of the materials.

One of the most obvious differences in the comparative economic conditions of the United States and Great Britain is that in the former country distances of one thousand miles sometimes separate the ores and the coal, whereas in Great Britain it is difficult to find a position in which the two are separated by one-tenth part of that distance. If the cost of transport in the two cases were approximately the same, this fact alone would, of course, render the competition of the United States impossible; but the average rate charged for railway transport in the United States is not more than one-fourth that charged in Great Britain, and lake transport is generally as low as we are accustomed to in Great Britain for over-sea freights.

In the United Kingdom the conditions under which the pig-iron industry is carried on vary considerably, although there is not the same range of difference between one locality and another that is found in Germany and the United States, owing to the fact that the distances are shorter, there being hardly a single case of either mines or works being more than a hundred miles from the sea. The cost of production nevertheless ranges from 32s. to 48s. per ton. The two most typical districts are Cleveland and West Cumberland, where the approximate costs at the present time, per ton of pig, are as follows:

	Cleveland No. 3.	West Cumberland hematite.
	s. d.	*s. d.*
Iron Ores	14.0	24.0
Coke	13.0	18.0
Labour	2.6	2.6
Limestone and Sundries.....	2.6	2.6
Totals.	32.0	47.0

In this table, the cost of ores is taken at approximately present market values, but it is necessary to keep in mind the fact that, in both cases, the iron ores at any rate are largely owned by, and under the control of, consumers, while in the Cleveland district most of the larger firms own and work their own collieries. The cost of coke given for West Cumberland is that assumed for Durham quality, although coke is made in some cases on the spot, near to the works, and in such cases is cheaper, if inferior in quality. The most serious drawback to the West Cumberland district is that of the high cost of fuel, which has usually to be carried about a hundred miles—more or less—at an average transportation charge of about 7s. per ton, being, I believe, as much as the cost of the railway transport from Connellsville to Chicago, approximately five times that distance. Another serious difficulty in the way of the progress of West Cumberland is the uncertainty that prevails as to the future of the ore-supply. This, as is well known, is the only district in Great Britain that raises considerable quantities of bessemer or hematite ores. The ore is expensive, rarely costing less than 9s. to 10s. at the mine, including royalty, which often amounts to as much as 2s. 6d. per ton. At this figure it compares unfavorably with the ores of Lake Superior, and especially with Mesabi ores, which, as I elsewhere show, are put on the railway for a few pence per ton. So costly, indeed, is the ore of West Cumberland that some of the largest firms in that district, although only a few miles distant from local mines, are introducing ores from Spain, more than a thousand miles distant, on a considerable scale.

There are several secondary districts in Great Britain that are able —for the present, at least—to make pig iron at a relatively low price, including Northampton, Lincolnshire, Notts, and North Staffordshire, which unitedly produce about a million tons of pig per annum from the lias stone. Of late years, however, these districts have made comparatively little progress, whence it may be inferred that they either have not the resources, or lack the encouragement, to extend their output. In some localities, indeed, the iron-ore resources, formerly plentiful, are now becoming rather scarce. Much of the ore supplied in these regions is quarried, and costs from 1s. to 1s. 6d. per ton in cars at the mine. I know of cases where pig iron is produced for 30s. to 31s. per ton, although the fuel has to be transported for relatively considerable distances, up to fifty miles. In some of these districts, raw coal is used in the blast furnaces, which restricts the output, and otherwise imposes limits on the conditions of working. Where this is done, however, plant has in a good many cases—and more especially in Scotland—been provided for recover-

ing the by-products in the smelting process, and, as these are currently valued at 3s. 6d. to 5s. per ton of pig, they materially aid the smelter who faces a low range of prices for his chief product.

Although there is some uncertainty about the failure of the iron-ore supplies of the United Kingdom, suitable for the bessemer pig industry, and although it is probable that British smelters will continue to be largely dependent on foreign ores, there is no cause for despondency; nor does it at present appear probable that any European country, at any rate, will be able to produce pig more cheaply for many years to come. It will naturally be expected that I should justify this view, which I now proceed to do.

No other European country, to begin with, has an equally abundant supply of ores at command, whether native or imported, with equally high-class and cheap supplies of fuel. France, Belgium, and Germany labour under the disadvantage of having, as a rule, to bring the fuel or the ores long distances. France, on the Moselle, where one half of the total pig-iron output is originated, has to pay high prices for fuel, which has to be introduced largely from Belgium or Germany. The principal Belgian works have to transport their ores from long distances, besides having inferior fuel to contend with, and being long distances from the sea. Germany has to contend either with dear ores or dear fuel—dear ores in Westphalia and Silesia, and dear fuel in Lorraine, Luxembourg, and the Saar. Great Britain is scarcely in any case more than thirty miles from the fuel, and, except in South Wales, is in no district even so far as that from indigenous ores. Moreover, the chief British iron-working centres are all on the seaboard,—Cleveland, Scotland, South Wales, West Cumberland, and North-West Lancashire,—while even inland districts, such as Derbyshire, Lincolnshire, Northamptonshire, and Leicestershire, have, in many cases, canal or river navigation at command. This great gain to British iron smelters can readily be appreciated by those who understand anything of the importance of cheap transport, and of a ready command of cheap tonnage for shipping purposes, which Great Britain enjoys to a larger extent than any other nation.

From another point of view, the future of the iron industry in Great Britain is full of hope. No other country has better supplies of fuel, all things considered. It is true that British smelters pay much more for their fuel than is paid in American iron-making centres, as a rule; but I am not aware that there is anything inherent in the circumstances of the case to justify this difference. On the contrary, I have recently, in the *Iron and Coal Trades Review*, taken some pains to point out that, if the British coke industry were to utilise by products and waste gases generally, they would be able

to furnish considerably cheaper supplies of coke to iron smelters, and this is a reserve of strength that can always be resorted to in case of need—the more readily as most of the large smelting firms have their own collieries and coking plants. There would be no good reason why pig-iron makers in Cleveland, for example, should pay 12s. to 14s. per ton for coke on which the railway transport is only 2s. 6d. per ton, if the coke-maker took advantage of his opportunities to economise in the process of coke making, and if British smelters were satisfied to accept and use coke from by-product ovens, as is done in Belgium and Germany.

Again, Great Britain, from her geographical and maritime position will always be able to command cheaper foreign ores than any other nation, and the difference in her favour, as against her three leading continental rivals, is not less than 1s. 6d. to 2s. per ton of ore, which means 3s. to 4s. on the ton of pig. Nor is there any good reason why foreign ore-supplies should be so costly as they have recently been. Over a number of years, the average cost of Bilbao ores delivered in England was not more than 10s. 6d. per ton, and to some of the leading firms—such as the Dowlais and Consett Companies, who have their own supplies—it probably has not exceeded 8s. per ton. Some apprehension has been felt as to the future of Britain's foreign ore-supplies. This has not been entirely without foundation, but, from the information with which I have been favoured from various quarters, I am pretty confident that new sources of supply will be made available from time to time, at not materially higher cost than those hitherto paid. Spain possesses many enormous reserves of ore that have hardly been exploited. The Asturias alone, when properly tapped, can furnish abundant supplies for years to come at a relatively low cost. I am myself at this moment interested in mines in that region, whence 66 per cent. hematite ores—the richest hitherto found in Spain—can be mined at not more than 4s. per ton. There may be many similar deposits. I would only add that, if, in the manner I have indicated, the cost of coke should be reduced to, say, only 7s. per ton at furnaces, and the cost of 50 per cent. ore should again be reduced to 10s. at ports,—which in a number of cases means at works,—even Great Britain possibly could produce hematite or bessemer pig for about 30s. per ton, which is probably as low as it will ever be produced in the United States or any other country. At any rate, the reports of my friend, Mr. Swank, of the American Iron and Steel Association, show that the prices of Lake Superior iron ore have not, over a series of years, been relatively cheaper at works in the United States than Spanish ores at works in Great Britain. Until 1894, the high-quality bessemer ores

of Lake Superior had never been nominally quoted at less than $4 per ton at lower lake ports, which probably means about 20s. 7d. ($5) per ton at works in Illinois, Ohio, or Pennsylvania, and even if we take these ores as 65 per cent. against 50 per cent. for the ores of Spain, it is clear that, if the bessemer ores of Lake Superior resume their old level, they will be relatively dearer than Spanish ores, representing, in fact, nearly 4d. per unit, at works, against about 2¾d. per unit, for the ores of Spain at British works on the seaboard. I do not, of course, overlook the fact that in special cases American ores are much cheaper than this; but I do not myself believe that so low a price can be continued over any great period of time.

Germany occupies a position of considerable importance in relation to the iron industry, not only statistically, but potentially. She has now reached a production of more than six million tons of pig iron annually, which is only about 2,500,000 tons per annum less than the output of the United Kingdom and the United States in 1896. The greater part of this output is due to Westphalia, where there are 54 heat furnaces, nearly all of them of the most modern description, against 28 in the Siegen district, 27 in Lorraine, 27 in upper Silesia, and 18 in the Saar. Most of the works, however, are of small size. The average number of furnaces to each works in Westphalia is only about 2½; in the Siegen district, 2¼; in upper Silesia, 2¾. In the Saar district, however, there are 18 furnaces for four works, and in Lorraine 27 furnaces for nine works, which is a better record.

There appears to be but little likelihood that Germany will be able to produce pig iron any more cheaply than she has done during recent years. The average price of basic pig iron has fallen from 44s. 6d. per ton to 42s. during the last four years, and forge pig has fallen from about 45s. to 40s. per ton, but these lower figures are extremely unremunerative. It must not be forgotten that about two-thirds of the iron ore mined in Germany is obtained from the Lorraine-Luxembourg district, while more than one-half of the coal and two-thirds of the coke are obtained from the Ruhr district. If better transportation facilities existed between these two districts, their economic circumstances would be greatly improved.

The future of the German iron industry has been already, and is likely in the near future to be still more, affected by the special conditions required to meet the basic process. About one-half of the six million tons of pig iron now annually made in the German empire is produced by this process, which called, until lately, for a minimum of 2½ per cent. of phosphorus. This metalloid was supplied chiefly through tap cinder, which twelve years ago was plentiful at 5s. to 6s. per ton, whereas it is now 16s. to 17s. per ton, and scarce at

that. The meaning of this is that tap cinder is no longer obtainable to an adequate extent, and has to be replaced by bog iron ores, which have to be imported largely from Holland and Belgium, at a high cost, although they are extremely variable in composition, and difficult to smelt, making it a matter of great difficulty to produce a uniform iron with these ores. Moreover, these bog ores, like the tap cinder, appear to be within measurable distance of exhaustion. But this is not all. The German works make large use of the ores of Alsace and Luxembourg. These districts unitedly produce more than eight million tons of ore annually, but the quality is not uniformly so good as formerly. The ores now being worked are lower in percentage of iron, which means that they cost more per ton of pig, and they are likely to cost relatively more in the time to come. Besides the phosphoric ores, the German iron smelters import considerable quantities of ore from Sweden, mainly from Grängesberg and Gillivara. The Grängesberg ores contain 60 per cent. of iron, and about 1 per cent. of phosphorus. The Gillivara ores contain 65 to 68 per cent. of iron, and from 0.1 to 1.0 per cent. of phosphorus. Both ores are said to be difficult to smelt, and it will readily be understood that their variable composition, especially in phosphorus, is a further disadvantage. These ores, of course, have to be carried over considerable distances, both by land and sea, so that they are relatively dear—considerably dearer than they would be at English works, which are generally on the seaboard. In the future, it is expected, the German works will need to import large quantities of Swedish ores, although they are not, where used, allowed to form more than one-third of the ore charge, as otherwise the phosphorus limit would be too low; and in any event, it appears, this phosphorus difficulty will throw increased burdens upon the German pig-iron industry, which will have to introduce larger quantities of the minette ores of the Lorraine district, in order to replace the failing supplies of tap cinder, at an increased cost to both the Ruhr and other districts.

In order to show the existing conditions in typical German smelting works, I append the following statement of ores used:

	Price per Ton. *s.*	Yield Per cent.	Charge per Ton of Pig ton.
Tap cinder	16.00	60.00	0.223
Bog ore	9.50	39.31	0.223
Roasted spathic ore	13.50	48.00	0.223
Brown iron ore	12.50	42.00	0.335
Minette ore 40 per cent	9.40	36.00	0.223
Do. 36 per cent	8.56	31.90	0.558
Swedish ores	15.50	61.00	0.446

It will be obvious that the assembling of such a variety of ores over so a wide an area, and the labour involved in mixing and sorting them, must all add to the ultimate cost of the iron produced.

In one respect the German iron industry is certainly as well off as that of any country in Europe. It has a very large supply of excellent coal, which produces a good coke, and, with the general adoption of by-product ovens, this coke can be produced cheaply and sold at a small profit. Whether it is so sold is, of course, quite another matter.* The total quantity of coal left in the German coal fields is calculated as twice the quantity left to the British consumer, but this is not a matter of concern at the moment. The advantage of cheap proximate supplies of fuel is, however, neutralised in all the German coal fields by their distance from suitable supplies of iron ore.

The conditions under which the iron ore of different countries are mined have greatly changed during recent years, but in no country to the same extent as in the United States. In 1877, according to Bell, 1.06 ton per man per day was about the average quantity of ore raised at some Lake Superior mines, and the hewers earned 7s. 1¾d., so that the labour-cost alone must have amounted to this latter figure. Speaking more generally, however, the cost at which the Superior ores could then be put into waggons at the mines was between 6s. 6d. and 8s. 6d. per ton, excluding royalties, whereas to-day ores of similar richness in the Mesabi range can be put into waggons for less than 1s. and in some cases for less than 6d., per ton.

One of the chief causes of this cheapening has been the introduction of improved methods of mining, especially in the comparatively new Gogebic and Mesabi ranges. The mining and shipment of these ores has been fully described in recent issues of THE ENGINEERING MAGAZINE (September and November, 1897). I need only add that no apprehension now exists—as there seems to have existed in 1877—as to the near exhaustion of the iron-ore-supplies of the Superior region ; † and that, as an evidence of how very cheaply iron ores can now be mined in Mesabi, one 60-ton steam shovel has loaded more than 254,000 tons of ore in twenty-five days of ten working hours.

Adopting, with variation of form, the figures given by my friend, Mr. Birkinbine,‡ I find the following to be his estimate of the average cost of fuel, ore, limestone, and labour per ton of pig in the leading iron-making districts of the United States three years ago :

---

* For some years past, the Westphalian coke syndicate has regulated production and prices.

† Bell stated in 1877 that there was a belief that a million tons annually was the possible limit of the output of Lake Superior ores.

‡ Annual Report of the Bureau of Industrial Statistics in Pennsylvania, 1894.

District.	Fuel.	Iron Ores.	Limestone.	Labour.
	s.	*s.*	*s.*	*s.*
Southern States.....	11/0	10/10	0/6½	3/4½
West Pa.....	6/8	17/8	1/7	3/6½
East Pa.....	13/10	20/2½	1/3	3/4
West Pa. (bessemer).	26/0	11/	2/1	3/6½

Mr. Birkinbine gives the cost of supplies, which varies from 30 to 40 cents per ton of pig, but no particulars of royalties, renewals, interest, and other factors. Apart from the last-named items, but including supplies, the figures show that pig iron was then produced in the south at 28s. and in western Pennsylvania at 31s. 2d. per ton. Since then the cost of production has been still further reduced.

I cannot say that I adopt these figures entirely without misgiving. It is difficult, for one thing, to understand why the cost of fuel per ton of pig could possibly be as much as 26s. in one part of western Pennsylvania, and only 6s. 8d. in another. Indeed, it is difficult to comprehend how, anywhere in a State like Pennsylvania, so rich in fuel resources, a ton of coke—which is about the average consumption per ton of pig—could cost so much as 26s., but I rest content with pointing out this apparent discrepancy, and with saying that I attach more importance to the other three cases quoted as being more within the necessarily somewhat limited range of my own observation.

So much has recently appeared in THE ENGINEERING MAGAZINE and other leading American and British publications on the vast changes that have taken place in the industrial situation of the United States within recent years that it is unnecessary to do more here than point out that, so far as present appearances go, cheap transport must always be the dominating factor in that situation. If the rival iron-making countries of Europe had command of equally cheap transport, American competition in Europe, or in any other part of the world, except on the smallest scale, would be impossible. No doubt, the resources of the United States in iron ores are much greater than those of any European country, so far as we know at present.* But it is not so with fuel supplies. There is a proximate limit to the fuel-supplies of the Connellsville coal field, which some recent writers regard as perilously near exhaustion. It is possible that the first check to the progress of the Pennsylvania iron industry, and especially to that of Pittsburg, will come from this quarter. We need not go further apace for the present, since the United States, Great Britain, and Germany are as yet the only countries in the world that make pig iron on a large scale, for both home-consumption and export.

* I do not speak of Russia, where the resources may be much greater than they have yet been ascertained to be.

AUTOMATIC MACHINERY THE SECRET OF CHEAP PRODUCTION.

By Hiram S. Maxim.

AT the beginning of the last century the relative cost of the necessities and luxuries of life was many times greater than now. Mechanical appliances were of the crudest nature, rapid production was impossible, and wages were low. In the absence of machinery everything had to be made by hand; production was slow and painful, and the hours of labour long. Indeed, it may be truthfully said that at that time man lived by the sweat of his brow. The working classes, which in the very nature of things must always be in the majority, had to content themselves with the bare necessities of existence. Their food and clothing were of the cheapest and crudest nature. Their dwellings were mere hovels, without light or comfort. As so much labour was represented in the cost of production, only very low wages could be paid, and the cost of manufactured articles was so great that the working classes could not be considered purchasers. As a consequence, the purchasing class was extremely limited, being confined to the comparatively rich.

Suppose that a clever mechanic, with no implements or materials other than those which could be obtained at that time, should have attempted to make a bicycle. First it would have been necessary to forge the various parts by hand out of steel. Then, by an extremely slow and laborious process, the tubes must have been bored and turned by hand. The cranks, the chain, the sprocket wheels, the spokes, and all the numerous nuts and screws would also have had to have been made by hand. Certainly from six months to a year of labour would have been represented in a single bicycle. Evidently the sale of such bicycles would have been extremely limited. At the present day a workman can produce at least one hundred bicycles in the time that would have been necessary to the production of one at the beginning of the last century. And what is true of bicycles is true of every other manufactured article. With this great diminution in labour and amazing increase in output, it has been possible to vastly increase the pay of the workingman, so that not only has the cost of the product itself been greatly reduced, but the higher wages paid to the working classes has converted them into a purchasing class, which has increased a thousand-fold the sale of the luxuries of life. Had no improved machinery been introduced, wages would still be extremely

low, and the working classes would not be able to enjoy any of the luxuries so common to that class at the present moment.

Two hundred years ago the workingman had to be content with a stone or mud floor. To-day it may be said with truth that the workingmen in America purchase more square miles of carpet in a year than was sold in the whole of Europe during the seventeenth century.

When books were written or engrossed by hand, the amount of labour represented in each book was evidently very great; consequently, they were so expensive and rare as to be practically unknown to the great majority of mankind. To-day, thanks to the improved automatic machinery employed, books can be made with great rapidity and cheapness. The result is that the workingman himself has become a large purchaser.

Suppose any one were to make Winchester rifles by hand; they would cost at least £60 each, and none but an extremely skilful man would be able to make them. The production would be small and the sale very limited, being confined to the comparatively rich. At the present moment, however, by the use of greatly-improved automatic machinery, unskilled workmen and boys are able to produce these rifles with great rapidity and cheapness. Instead of costing £60 each, the actual cost of their production is probably about £1.4s each, and they can be purchased at retail at, say, £3 each. As the sale is not confined to any particular class, it is, as a consequence, very extensive, these rifles being purchased in large numbers throughout the whole world. Without machinery, the rifles would cost £60 each, and would have to be sold for at least £100 each, and perhaps twenty skilled mechanics might supply the demand; but to-day hundreds of skilled mechanics are employed in tool-, gauge-, and machine-making, in order to keep employed some thousands of relatively unskilled mechanics.

A watch in the last century represented a great amount of labour. The market was small, and very few were made, but to-day watches are largely made by automatic machinery, and the cost in labour has been so reduced that their use is not confined to the rich. The working classes, who in the first instance were not purchasers at all, have become by far the largest purchasers, thereby creating a new demand, enabling thousands to be employed in watch-making where only hundreds were employed before.

From the foregoing it will be seen that the great change which has come over the manufacturing industries during the last one hundred and fifty years is due altogether to the improvements in machinery and mechanical appliances. It will also be seen that by the cheapening of production, especially through the decrease of labour

required for any particular article, the manufacturer has been able to pay to the working class a much larger wage, and this, together with the cheapening of the product, has converted the working class itself into the most important purchasing class that we have in the market to-day. The whole trend of western civilization is in the direction of rapid and cheap production. Everyone whose eyes are not blinded by trade-union fallacies must see that, the greater the production and the less the labour represented in the article, the greater the market must inevitably be; production and the market react upon each other.

The artisan classes may roughly be divided into two categories.

First, those who, from their natural ability and surrounding circumstances, have become skilful in the art,—men who, say, in metal working, are able to do the finer kinds of work, such as accurate turning, milling, tool and gauge-making, and, in some cases, designing of new machines or new methods of production. These men receive relatively high pay in all countries, and, by their skill, are able to make tools and machinery and to keep them in order, so that work may be turned out with accuracy and great rapidity.

The second category, which includes about nine-tenths of the whole, consists of the unskilled workers,—men who for the most part are not sufficiently clever to become, or who have not had an opportunity of becoming, skilful mechanics. These men are not able to make, design, or keep in order new machinery or appliances, but, when the machinery is once made, they are able to to turn out accurate work, and one of them can easily take charge of from four to six machines. It is the employment of this class of men at their relatively low rate of pay which enables manufacturers to turn out cheap and accurate work. But it must not be supposed for a moment that the actual pay received by these men—these unskilled workers—is not sufficient to enable them to live in comfort. If a man is intelligent, he may in time become skilful in the use of the machines in his charge, and, if he is very active and works at piece-rates, he may earn as much as a skilled mechanic.

An unskilled mechanic is as much a citizen of the country in which he lives as any one else, and is entitled to the same degree of protection and consideration as is accorded to the skilled mechanic. The skilled mechanic has no right whatsoever to create any artificial system which will restrict the liberty or the facilities of the employer to employ this important class of the community.

In the United States, especially in the New England States, very high salaries are paid to really skilful, able, and active mechanics. As a rule, there is no such thing as a fixed wage, each man being paid in proportion to his skill and his application to business, and every

encouragement being given to inventive genius. Any man who can cheapen a process by the designing of new tools, or the improving of old ones, is considered of great value to the manufacturer, and is paid in a degree corresponding to the benefits derived from his ability. In New England, among the higher class of mechanics, it is not so much a question of the production of articles which are actually made to sell as a question of improvement in the machinery which will enable the unskilled worker to produce these articles with great rapidity. The New England manufacturer is alive to the fact that his success depends upon rapidity and consequent cheapness of production, and that this cheapness can be brought about only by the use of automatic machinery which will enable him to employ unskilled labour. He finds it to his interest to pay the skilled mechanic who assists him wages which would be considered very high in any other part of the world. By this system the New England manufacturer, who may pay a skilled mechanic $5 a day, is able to place in the European market many articles of manufacture at prices much below those which prevail in Europe. In England there is a great degree of conservatism, not only among the working people, but also among the manufacturers themselves. When I first came to England, if I went into a factory and saw work being executed on a very old and crude system, and suggested any improvement either to the employer or to the workman, I at once found them very combative. They considered it was necessary to say only that it was the English system.

It is amazing how strongly certain nations are wedded to old ideas. According to their way of thinking, the fact that a thing or a system is old is sufficient evidence of its great value. In Turkey they manage to get along without roads. Their ancestors, thousands of years ago, employed trains of camels and horses for carrying goods and passengers, and why should that not be good enough to-day? Many are content to scratch the surface of the earth with the root of a tree, when a good plough may be purchased for about 8s., and, notwithstanding that it has been said that the plough is the most useful of all inventions, even the Spaniards still employ a spade for turning over the earth. Bricks are now made in Spain exactly as they were made by the Romans two thousand years ago. The wheels of their agricultural carts are merely large discs of wood, and their oxen, instead of yokes, have a piece of timber lashed to their horns.

All the mechanical and agricultural implements employed in the east and south of Europe are of the roughest and crudest description. When Horace Greeley was travelling in France, he saw an agriculturist cutting his grass with a sickle. He said: "Don't you know, my man, that with a scythe you could cut twice as much grass?" The

Frenchman looked thoughtful for a moment, and replied with great deliberation: "I don't see how that can be possible, because I have not twice as much grass to cut." Where the field of employment is extremely limited, as in this case, there may appear to be some excuse for conservatism, but the manufacturer of to-day cannot afford to be conservative. He finds that many others are already in the world-wide field with the most approved appliances, and, unless he arms himself with the very best instruments that modern civilization can furnish and has complete and unrestricted direction of the men who use these instruments, he will be left far behind in the race. Spain, Portugal, parts of Italy, and the whole of Turkey are extremely conservative. Germany and the United States, on the other hand, are extremely progressive. Numbers of immense workshops are at present being erected in Germany. These are equipped with the finest tools that can be produced—generally of the American type.

In New England the manufacturer is always seeking something new; he cannot afford to use old or imperfect tools. In England the tendency of the manufacturer is never to get a new tool so long as there is anything left of an old one. In New England the manufacturer, as a rule, takes great pride in the cleanliness and order of his shop. He thinks of nothing but his business, and of bringing it to the highest degree of perfection. He has no interests outside his factory. In England, on the contrary, the manufacturer is apt to look on his works only as a necessary evil. As a rule, he takes very little interest in what is going on, does not identify himself with the working people at all, and is always looking forward to the time when he shall retire from business and have nothing more to do with commerce or manufacture. In New England the working mechanic takes great pride in learning his profession thoroughly. He "talks shop" in season and out of season, and, as a rule, has a very extensive and well selected kit of tools. The British mechanic looks upon his trade only as a badge of servitude; he never thinks of his business when he is not obliged to, and, as far as tools are concerned, is often contented with a centre punch and a hammer.

But this relates principally to the majority of English shops of fifteen years ago. I have noticed that the introduction of new American tools and machinery into England, especially those made by Messrs. Pratt & Whitney and Brown & Sharpe, has opened the eyes of many of the manufacturers, and many shops in England at the present moment are being equipped with American tools. This is especially true in bicycle work. Still, there are a great many English factories that would be greatly benefited by a fire, or, in fact, anything that would destroy their old tools.

But the question of tools is not the most serious question that the English manufacturer has to contend with. A very clever Scotchman, who was once the manager of our works, said that the greatest obstacle that he had to contend with was "organized idleness," while the present manager of our gun works, although an engineer of the very highest order, confesses that his duties are more those of a detective than an engineer. Trade unionism has reached a stage of development in England unknown in any other part of the world, and perhaps the most malignant type is that which is found among the metal workers. The union known as the Amalgamated Society of Engineers not only attempts to prevent what they are pleased to call unskilled mechanics from working machines at all, but, if their own men are themselves employed on machines, they resort to every trick and expedient to limit the output. In many cases a lathe may be run a complete day without ever taking a cut at all. They oppose the introduction of new systems or new tools; in fact, all their influence is directed against rapid and cheap production. A large English manufacturer lately said to me that there are more than a hundred different ways in which the employee can cheat the employer.

Shortly before the recent strike and lock-out, finding that the system employed in our wheel works was not only wasteful in labour, but foolish in the extreme, I suggested that certain changes should be made which would save several operations and considerably cheapen the work. The superintendent, however, said he did not dare to make the change; that the wheels must be delivered on a certain date, and that any change which reduced the amount of labour or cost of production would be opposed by the trade union and probably lead to a strike. Even now, he said, I have to handle these fellows with gloves; I have all I can do to keep them at work as it is. He thought it would be best to attempt to get the wheels made in America.

The fact is that the interference of the trade unions is so vexatious and arbitrary that English employers feel disposed to make almost any sacrifice in order to get rid of it, and it appears to me that the only hope lies in the direction of the Federation of the Employers, a society recently formed in England. If the employers can be made to understand that the principal obstacle which prevents England from competing with the other nations of the world in the manufacture of metal articles is trade unionism, and that the only practical way of combating this union is by a counter-combination on their own part, then the time cannot be far distant when trade-union societies will be robbed of their power to do harm; then once more it may be a pleasure to do business in England.

As several of the principal labour leaders of to-day are personally known to me, having, in fact, graduated from our own works, where absolutely no unfair treatment or grievance exists or ever has existed, I think I may be allowed to express an opinion on this subject. It is not necessary that there should be an actual grievance in order that the professional agitator may interfere between master and man. The rank and file of trade unions, as a rule, are men who never think. The labour leader is a man with a glib tongue who does not like to work with his hands. He reads the newspapers and a few books, learns to mouth a few big words, and generally commences in a small way. He tells his fellow-workers that they are downtrodden, and little better than slaves; he speaks of the "noble British workman," and caters to their vanity. It might never have occurred before to the workmen that they were receiving any unfair treatment, but the agitator tells them "that the employer is living off their blood." He promises to change all this. If he is a plausible talker, he soon gets a following, and his first attempt is to breed some quarrel between the employer and the employed. Some machinery grievance is trumped up. This may be so extremely foolish that the men themselves cannot be fooled by it. But this does not disconcert the agitator. He drops the subject, and seeks something else. For instance, if he advises the men to strike against piece-work and finds that piece-work is not being done, he makes a demand that the employers shall sign a contract that they will never allow piece-work to be introduced, and this may lead to a strike. The strike, once on, gives the agitator his first opportunity to distinguish himself. He makes speeches; these speeches are reported in the papers, and by degrees he works himself up until he becomes one of the chief agitators of the country.

A great deal has been said about the necessity of harmony between the employers and the employed. There is no question but what this harmony exists in a great many of the American shops, notably those of Pratt & Whitney and Brown & Sharpe. Mr. Pratt once said to me: "It is a pleasure to do business with the kind of men we have in our works. There is a perfect understanding between us, and not the least friction or tendency on the part of the men to take advantage of us."

In Germany, also, there seems to be a complete understanding between the master and the men in regard to cheap and rapid production. The German workman, as a rule, understands that he has the whole world to compete with, and he is willing to meet the master half way in order to capture the work. I remember a case in point. By a mutual understanding between the master and men, a contract was taken at reduced wages, with the result that the work was so

cheapened that the master was able to pay full rates at the end of the first year.

In England, on the contrary, it is quite out of the question to come to any mutual understanding of this sort with the workmen. I know one case where a large contract was taken on the basis of existing wages, and no sooner did the men find that the contract had been signed than they struck for an increase. As the contract had been taken with only a small margin of profit, it was found impossible to concede their demands. The work was taken to France. When the strike was ended, there was nothing to do. The Frenchmen got the work, and they have kept it, ever since, and the English works have now been closed for several years.

In order to produce the best results, it is not only necessary that large and airy works should be provided, and that the tools should be of the highest possible character, but that the workmen should have a certain amount of sympathy with the masters. They should understand that their own interest is so identified with the success of the works that it is best to work their machines to the greatest possible advantage. If the workman cannot be made to understand this; if he attempts to cheat by keeping the tools idle, or by running them slow, or by taking too small a cut,—the whole object of the employment of high-priced automatic tools is defeated. The production becomes slow and expensive, and it will be found impossible to compete with other factories employing the same class of tools where the workmen understand that the interests of the master and their own are identical. If England wishes to compete successfully, and to maintain the position which she ought to occupy as a great manufacturing nation, she will not only have to equip her factories with the latest and best of instruments, but will also have to obtain the earnest coöperation of the men who work these instruments. The antagonism which at the present time exists between master and man is altogether artificial. The great majority of employers treat their men with absolute justice. Unfortunately in many cases, the wages paid are so high as to absorb all the profits, leaving nothing for the master. If the men were left to themselves, they would probably very soon see that it was to their interest to do their best, and look upon their employer as a friend and a benefactor, but, instead of this, the workingman has been taught by the professional agitator that his greatest enemy is his employer. He is made to believe that to be a capitalist is to be a criminal, and that to cheat his master is the only way to get square with him, and he is foolish enough to pay the man who teaches him this folly sufficient to enable him to live without working.

The first strike that we had at our works was due to our refusal to

promise that piece-work should never be done on our premises. When our men had been out some months, we succeeded in bringing over from northern Italy, Switzerland, and France some of the best workmen that I have ever seen in Europe. These men wished to work at piece-rates. I asked them how many hours a week they wanted to work. They held a meeting, and decided on seventy-two hours per week. Intimidation having failed to influence the foreigners in the least, the Amalgamated Society attempted to reason with them. They found that it was quite impossible to reason on the question of piece-work, as the foreigners all wished to do piece-work, "because they could earn such a lot of money at it." The Amalgamated Society, however, were not bound to confine themselves to the truth; so they issued a little circular printed in three languages, assigning quite a different cause for the strike.

I herewith give the French version.

AUX TRAVAILLEURS MECANICIENS!

En présence des tentatives de diminution des salaries et de l'exagération du nombre d'heures de travail imposé, sous peine de renvoi, par la Maison Maxim-Nordenfelt, les ouvriers ont quitté les ateliers et se sont mis en grève.

La maison s'attache maintenant à se procurer des ouvriers étrangers, et a pu ainsi trouver quelques Français qui, dans l'ignorance de la situation, ont accepté du travail.

Dans le but d'arriver à une commune entente sur les diverses mesures à prendre, le comité de la grève a resolu de tenir DIMANCHE PROCHAIN, 2 MARS, 6 HEURES DU SOIR, AU "BEAR AND STAFF," CRAYFORD, UNE ASSEMBLÉE, à laquelle tous les Français devront prendre part.

Il sera donné lecture d'une lettre de l'Union des Ouvriers Mécaniciens du Department de la Seine engageant vivement les grévistes à résister contre l'odieuse tyrannie dont ils sont menacés par Maxim-Nordenfelt.

On behalf of the Strike Committee,

JAMES HILLYER, Chairman;
PHILIP DAVIES, Treasurer;
JOHN BARKER, Secretary; and
J. H. WATSON, Delegate of the Executive Council of the A. S. E.

From this circular it will be seen that the reason assigned for the strike by the Amalgamated Society of Engineers was not the refusal of the Company to promise never to allow piece-work to be introduced, but "the diminution of wages, the increase in the hours of

work imposed under penalty of discharge, and the odious tyranny with which they were threatened by the Maxim-Nordenfelt Company."

When our foreign workmen found that they could work only fifty-four hours a week, many of them started little shops of their own. Some made electric bells, some toys, others instruments of precision. One came and asked me where he could buy a nice foot-lathe. I asked him what he wanted of it, and he said: "What can I do? I work only a few hours a day; you won't let me work any longer; what am I to do with the rest of my time? I don't drink; I can't loaf; what shall I do? I must do something to amuse myself? Why not make something to sell?" Since the eight-hour system has been introduced into the Woolwich Arsenal, it has been found that even Englishmen find the hours too short, so that many of them have started little shops of their own, generally in the bicycle line, and now there is a great wail from local bicycle makers because they are undersold by men who receive a full day's pay for part of a day's work.

It is often said that the Americans compete successfully with English manufacturers on account of the duties, the Americans being allowed to bring their products into England free of duty, while, on the other hand, they demand excessive duties on all imports into their own country. When the United States was a young country, much was said about protecting "our infant industries." It was shown that it was only by shutting out foreign competition that American capitalists and manufacturers could be sufficiently encouraged to commence manufacturing in the United States, but it was not proposed that this protection should be permanent. It appears to me that, when the first ton of steel had been exported to England, there was no further occasion for a protective tariff on steel, at least. When I was a small boy at school, it would have been very convenient for me if I could have had protection from the bigger boys. But, when I became the biggest boy in the school, I needed no protection. So it is with the United States of to-day. No longer the stripling of fifty years ago, the nation has grown into a sturdy manhood; is, in fact, at the present time, "the biggest boy in the school," and requires no protection against the competition of the smaller boys. However, I presume that protection will prevail in the States so long as the glib-tongued politicians are able to deceive the majority of voters by the bug-bear of foreign cheap labour. Foreign labour, as a fact, may be cheaper than in the United States, but the American, as a rule, is able to produce more work for an ounce of gold than any other man on the planet. Why, then, the need of protection?

THE CONTROL AND FIXATION OF SHIFTING SANDS.

By John Gifford.

THAT branch of forestry known as silviculture is merely the application of superior skill and knowledge to the production of wood-crops or other valuable products such as naval stores, cork, oils, waxes, gums, tanning materials, medicinal barks, camphor, and rubber. There has been, and is still, a great deal of nonsensical talk on the subject of forestry throughout the United States, and impractical people who love trees and have no money invested in woodland have senselessly blasphemed the lumbermen. Forestry is little more than scientific lumbering, and forests grow to be cut and utilized. The best system to pursue is the one which pays the best. To-day in forest utilization America equals, considering all things, other nations, and no doubt, in the course of time, when the condition of affairs warrants it, an American forestry system will be evolved out of the present lumbering system.

The true forestry workers of the United States are not endeavoring to curb the lumberman, but to aid him in preventing the reckless destruction of forests by fire. They are mainly striving to secure government aid for the prevention of fires, and the apprehension and proper punishment of those guilty of setting them.

At the same time, however, forestry is something more than scientific lumbering, in that it accomplishes other objects of equal, if not greater, importance. Whenever a forest is planted or preserved for these indirect purposes, the income must be counted in benefits received, not in cash, although a forest may at the same time yield a fair income on the amount invested and accomplish these benefits.

In the region of summer resorts it is profitable to preserve the forest for esthetic purposes, and in that way entice a greater number of tourists and invalids. In prairie regions it pays to plant forests to protect crops and other property from winds. In mountainous and hilly countries it pays to preserve forests for the prevention of erosion, landslides, floods, and avalanches. Where there are farms in valleys, it pays to keep the rough mountain land in forest, because it disintegrates the rocks, and brings to the surface valuable inorganic materials from the deeper layers of soil which gradually wash down the mountain sides and enrich the farmlands below. And it pays to plant forests in certain places for the fixation of shifting sand, which is the subject of this paper.

THE SEA FACE OF THE DUNES ON SEVEN MILE BEACH, NEW JERSEY.

Along the shores of oceans and other large bodies of water, especially in the region of the estuaries of large rivers, there are usually immense masses of shifting sand. It is not within the scope of this article to describe the formation of these sand-banks. It is sufficient to say, therefore, that they usually begin as long sand-bars behind which there are sheets of still water. These shallow bays in the course of time fill up with mud, becoming salt marshes intersected by thoroughfares, salt ponds, and winding creeks. In the meantime the long, flat sand-bars have developed into sea islands, or beaches. When the tide falls, the sand of the shore, ground into powder by the waves, and dried by the sun and wind, is blown in the direction of the prevailing winds, usually inland. The sand moves like snow, until it meets an obstruction, when a dune, or sand-hill, forms, equal in height to the obstacle. A section through a dune shows a beautiful stratification, the sand having been deposited in thin layers, always varying, however, with the nature of the sand, the velocity of the wind, and the obstructions, large or small, which it encounters. These dunes are not hurled bodily by the breezes, but little by little, forming and reforming, forward and backward, changing, in fact, with every caprice of the wind, gentle and almost imperceptible during a light sea breeze, but a stinging, blinding sand-blast in times of gale. In spite, however, of all these minor changes, the sand mass is gener ally moving, perhaps only a few inches a year, in the direction of prevailing winds. A great deal depends upon the day winds, in that at night the sand is damp and firmer. And so mountains of sand are formed which are often held temporarily by hardy plants which have gained a precarious footing, but which sooner or later, unless watched and fixed, begin to shift, engulfing meadows, farmlands, lakes, bays, inlets, in fact, anything unable to check its course. Very often these-

dunes are held by a natural growth of plants, and no doubt, when the conditions were different, beautiful forests have grown. In places where these forests have been destroyed the dunes have become restless, and in other instances, where great changes have occurred in the shore line, the forest holding one set of dunes has been, or is being, overwhelmed by those of more recent formation.

There are several instances where lighthouses have been increased in height because of the sand which had engulfed them. In one place on the New Jersey coast I once stumbled upon the corner of an old rail-fence which had been buried and exposed again on the ocean side. It marked the site of an old field. On the North Carolina dunes, chimneys projecting above the sand belong to the houses of an old fishing village. In France and other parts of Europe villages have been buried. At Soulac in Gascony a cross was discovered projecting above the sand. Further investigation showed that it was attached to a steeple, and later a well-preserved church of the thirteenth century was excavated. The church is now in use.

The sand of dunes, although it varies in nature throughout the world, is extremely fine on the eastern coast of America. It beats through cracks in dwellings, frosts the window-glass, and sifts into one's pockets, shoes, clothing, and hair.

On the Pacific coast there are few dunes. In the region of the north of the Columbia in Washington and Oregon there are extensive accumulations of sand, behind which there are bays, as along the Atlantic coast. A part of this area is covered with the beach pine

A DUNE NATURALLY BOUND FOR A TIME BY SAND SEDGE.

(*Pinus contorta*). In this region this tree is low-spreading, with small, faulty trunk and of little timber value, so that the beach groves are not in danger of being sacrificed in a region where there is such an abundance of excellent timber.

There are extensive dunes in the region of the great lakes; especially in Michigan and in Ontario farms are being invaded by moving sand-banks. On the Atlantic coast there is an immense area of shifting sea-sand. These dunes, in all their stages, may be seen to advantage on Cape Cod, the New Jersey coast, and Cape Henlopen. Here and there along the shore excellent bathing-beaches are being damaged, the coast is constantly changing, and in many places valuable harbors are being invaded and inlets choked with sand. In

A DUNE, HELD FOR A TIME BY A GROWTH OF SHRUBBERY, BEING GRADUALLY SHIFTED BY THE WIND.

many places what were formerly salt bays filled with oysters and fish are now fresh, stagnant ponds. The truth is briefly this: the sandy coast-line of America, which is at present constantly changing, can be rendered practically stable by the application of forestry and engineering skill. This is worth while, however, only in places where the injury occasioned by the sand warrants it.

The province lands of Cape Cod are a barren stretch of shifting sand-hills. As early as 1826 and 1838 plantings of beach grass were made by the United States government and the town of Provincetown at a cost of $28,000. Since that time more money has been spent. In the meantime, however, the natives have cut the trees and even removed the surface soil, so that the mobile sand began to drift.

Three immense ridges of dunes have formed, which are moving inland toward the town and harbor at the rate of from ten to fifteen feet per annum. The board of harbor and land commissioners, in charge of these lands, has begun to systematically fix these sands by extensive plantings. An immense dune may be seen near Avalon, New Jersey. In its lee there is a luxuriant forest of red cedar, holly, sour-gum, maple, magnolia, hackberry, oak, mulberry, and other trees, with masses of grape-vines and Virginia creepers. It is a picturesque sight from the crest of the dune, which equals the trees in height. The trees, in fact, constitute the obstacle that has formed the dune, which is leading to their destruction. On the land side there is a dense mass

RED CEDAR FOREST ON THE BEACH NEAR AVALON, NEW JERSEY.

of dark-green foliage, beyond which there are green meadows intersected by thoroughfares and bays. On the ocean side there is a mass of sloping sand, out of which project the jagged trunks and branches of smothered trees. The fine sand comes from the great ocean mill, ascends the dune, and falls over its crest in minute cascades. When a stiff breeze is blowing, it skims along the surface and shoots over the crest like a sand-blast, trimming the tops of the trees as flat as though shorn with shears.

It is a mistake to suppose that this sand is sterile and unproductive. When mixed with humus, which is abundant in the meadows near by, it is capable of yielding excellent crops. It is not pure silica, being

generally mixed with particles of other substances, such as magnetic iron, shells, and mica. Its texture and density are such that there is sufficient capillarity to keep it moist. Beach sand, which appears so barren in a bare and shifting condition, is able to produce a magnificent growth of forest trees in protected positions. The immense oaks and hollies on the Jersey beaches and the beech forest near Scheveningen in Holland attest the ability of the beach sand to support vegetation.

Europe affords the best examples of the complete reclamation of shifting sands, barren heath lands, marsh lands, and other waste places, for the density of population has forced the inhabitants to be less lavish with land and less wasteful of resources than are the people of America.

Extensive dunes have been reclaimed along the Baltic and North seas. At the founding of Copenhagen, for instance, in the eleventh century, the island was clothed with extensive forests. The woodlands passed gradually from the hands of the government to private individuals, and, as is invariably the case, were stripped of trees. The drifting sands of the north shore moved, in the course of two centuries, several miles inland, covering farms and villages. Realizing the danger at last, the people set to work, and now the sands are held in bondage by extensive forests of oak and beech.

In Holland the beaches were guarded, in that they served as natural dikes for the protection of farmlands. The marshland was drained and tilled, creeks became canals, and the dunes, a menace to other countries, served to protect the industrious Dutch from incursions of the North sea. Although the Dutch dunes have always been watched, and have been less mobile than those of other countries, it is only within recent years that systematic dune-planting has been in operation. The government, aided by the Dutch Heath Society, is now actively engaged in forest-planting on all dune land owned by the State.

Much could be said of experiences with dunes in other parts of the world. It is, however, in France, in the department of Gascony, that we find the most striking and valuable object-lesson.

In the early part of this century the condition of the territory, known as the Landes, which is bounded on one side by the rivers Gironde and Garonne, on another side by the river Adour, and on the other by the bay of Biscay, was, in brief, as follows: there were miles of marshy, treeless wastes, covered with a low, but dense, growth. It was damp, unhealthy, stagnant in places, and sparsely inhabited. The few people who lived there depended upon their flocks. There were practically no roads, and communication was so difficult that the people moved from place to place on stilts. The men had little to do

but watch their sheep; so they took to knitting, and it is not uncommon even to-day to see a shepherd standing high on stilts, balancing himself with a staff, and placidly knitting socks. Although the country has improved, and is no longer desolate, unproductive, and unhealthy, a few of the people still cling to their stilts; in fact, in several places in the back country the mail-carriers use stilts.

All this region is underlain with a substance called *alios*, which is a sandstone, the cementing material being organic matter and compounds of iron. It forms an impervious hardpan. Canals have been dug, forests planted, and roads—both wagon and rail—constructed, so that the Landes is one of the most prosperous regions in France.

MEADOW BACK OF THE DUNES ON SEVEN MILE BEACH, NEW JERSEY.

The condition of the Landes was directly due to the immense dunes which arrayed themselves in lines along the shore of the bay of Biscay. They moved inland and covered villages, clogging up rivers and inlets. The rain which fell in the Landes was unable to escape into the ocean. It banked up behind the dunes, and flooded large areas. During Roman times these sand masses were wooded and stable, but, in the hands of the French peasants, they were stripped and rendered mobile. The damage done by these moving sands so increased that the government officials studied the work, and devised and executed plans, and now, thanks to de Villers, Chambrelent, and Bremontier, the pioneer workers, the dunes and landes are covered with a beautiful growth of

A TYPICAL NATIVE OF THE LANDES.

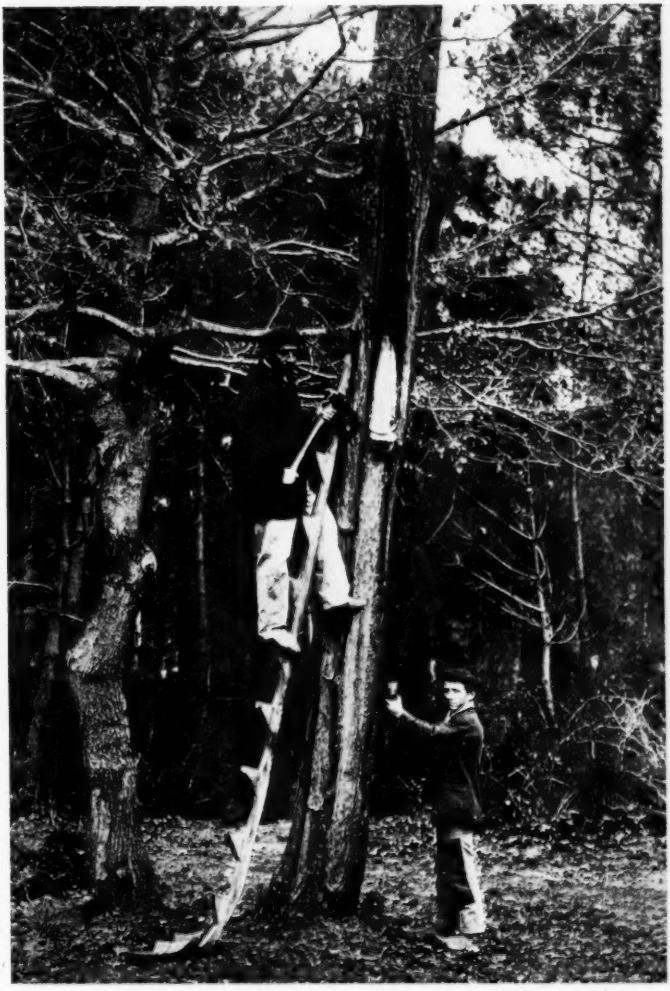
the maritime pine. The region is now a famous health resort, combining the beauties and pleasures of the sea-shore with those of a well-managed pine forest, which extends almost to the edge of the ocean. The manner of reclaiming these dunes is not complex, and, although the result of years of experiment and experience, can be told in general in a few words.

COLLECTING PITCH IN THE FOREST OF LA TESTE, ON THE DUNES NEAR ARCACHON.

A littoral dune was constructed straight along the shore from the mouth of the Gironde to Bayonne. This dune is the secret of all success in the fixation of shifting sand. It is simply a bank of sand of certain dimensions, with a certain slope suited to the condition of affairs. This protective, or littoral, dune is formed as follows: a double fence is constructed of brush, or of palisades driven in the sand. This stops the sand which comes from the ocean. Soon a ridge of sand forms, equal in height to the fence. A double fence is used, as it gives breadth to the dune, and stops the sand which blows through the fence on the ocean side. As soon as a ridge of sand is formed as high as the fence, the old fence is pulled up, or a new one built on top; and so on, until a dune of the height desired is formed artificially. The proper height of a protective dune is 33 feet. It should slope 25° towards the sea, and may be 60° on the land side. The dune must be at least 300 feet from high-water mark. After the dune has reached the proper size, it is kept in shape by the sea marram (*Psamma arenaria*). This peculiar plant, called *gourbet* in France, is exclusively used for fixing the sand on the littoral dune. It has long, much-divided rhizomes, and will grow well only when covered with fresh sand. The dune must always be kept in shape. If sand accumulates in any one spot in undue amount, a draft is formed, which may end in a breach of the littoral dune. *Gardes cantonniers* are stationed along the dune, to watch it closely, and here and there on this long straight sand-bank groups of men and women may be seen digging up the *gourbet* in places where it is too thick, and planting it where needed. Constantly the dune is watched and mended; the forest, villages, and fields in its lee are dependent upon it, and it in turn is dependent upon the humble, but persistent, *gourbet*.

After the formation of the littoral dune comes the work of planting in its lee. The surface of the sand is covered with brush arranged like the slates on a roof, with a shovelful of sand here and there to hold it down. Then the seeds of *Pinus maritima* are sown, with seeds of other plants to shade the young pines, and seeds to attract insectivorous birds. The pines usually come up well, and grow quickly, although close to the littoral dune they are gnarled and stunted by the salt winds. Thus the sands are fixed, and, although the forests do not yield a good interest in cash, they are of incalculable value to a large proportion of the people of Gascony—in fact, indirectly, to the whole of France. Fire lanes have been constructed across the dunes, and, thanks to the watchfulness of the guards and the rigid enforcement of laws, fires are almost impossible.

Very little cutting is done in these forests, the revenue coming mainly from the resin industry. Owing to a lack of roads and in-



METHOD OF COLLECTING PITCH IN THE FOREST NEAR ARCHACHON.

sufficient means of transportation on these dunes, only the most valuable timber is marketed after being tapped for resin. If it is desirable to remove a tree, it is bled to death before being cut. All other

A FIRE LANE (GARDE-FEU) ON LA GRANDE DUNE.

trees are tapped very carefully, and are in no way injured by the process. In fact, bled timber is considered superior to unbled in France. The Hugue method of orcharding is used, a system which does not injure the tree, but gives a resin of better quality and more abundant turpentine. Another article, however, could be written on the French method of turpentine orcharding.

Other industries have started, the people have improved, and the country is more fruitful and beautiful, so that, through the agency of trees, a new province has been practically added to France.

THE ECONOMY AND EFFICIENCY OF THE LARGE GAS ENGINE.

By Dugald Clerk.

IT is not an easy matter to decide what shall be considered a large gas engine. Indeed, when compared with steam engines, it cannot be said that any large gas engines are yet in existence. In one sense the engines are large enough,—too large,—but, in the sense of giving great power, gas engines have not yet reached the really large stage. They are still clumsy and heavy for the power developed, and much improvement is required, considered from a purely mechanical point of view, in order to make them, in this respect, comparable with steam engines.

The gas engine, however, is improving surely, though slowly, and in time to come, no doubt, there will be gas engines as powerful as any steam engines ever built.

Although, in one sense, no gas engine can be considered large, yet existing gas engines are very much more powerful than was at one time believed possible. When the present writer first felt the fascination of the gas-engine problem,—a fascination which, it may incidentally be said, has proved fatal to many inventors,—the largest gas engine in Britain gave about 3 h. p., and this was considered at the time a most remarkable engine; indeed, the noise and vibration caused by its use gave the impression of considerable power, and made engineers feel that, if the engine were made much larger, it would be difficult to design a building strong enough to hold it. This engine was the well-known Otto and Langen, manufactured by Messrs. Crossley, of Manchester, who were then established in a small and unpretentious works, happy in turning out no more than one hundred engines per year of an average power not exceeding 1½ h. p. each.

This was the year 1876, when the old "Shooter" type, or Otto and Langen atmospheric engine, attained its maximum use. There were then practically no other makers of gas engines in Britain. The Lenoir engine had been made for some time at the Reading Iron Works, but it had proved a failure, and only a few were then being built in various small works throughout Britain. The Messrs. Crossley were, for all practical purposes, the makers of the only commercial engine.

Although the Lenoir engine was at this time a commercial failure,

yet there were then many examples at work in England, and even so late as 1885 I inspected a Lenoir of ½ h. p. at Petworth, the residence of Lord Lecconsfield, which had been at work for more than twenty years pumping water for domestic purposes. It was in good condition, and had given but little trouble. In the same year I also examined a Hugon engine at the brewery of Messrs. Truman, Hanbury & Co., in London,—also ½ h. p.,—which had been at work there for many years. I knew of another of the same size at work in a druggist's establishment in London.

Figure 1 is an illustration showing the general appearance of a ½-h. p. Lenoir engine about 1866. This was the large gas engine of that day. The engine was double-acting. It drew in a charge of gas and air at atmospheric pressure during the first part of each stroke, and fired that charge by means of the electric spark ; the pressure in the cylinder rose and acted during the latter half of the stroke ; at the

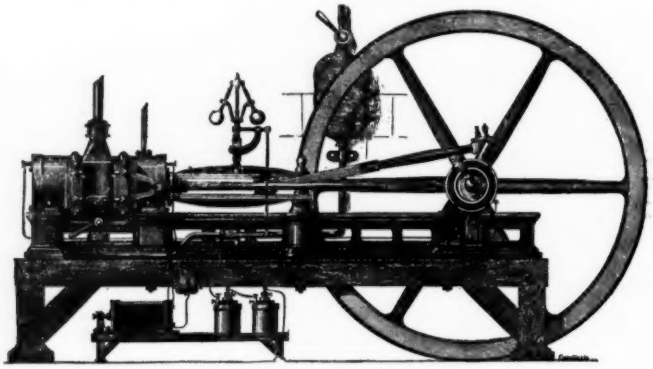


FIG. 1. LENOIR GAS ENGINE.

end of the stroke the exhaust valve was opened, and the contents were discharged, the same operation being repeated on the other side of the piston.

The illustration just above shows a Bunsen battery and induction coil as then used to produce the electric spark. The governor is shown as of the ordinary steam-engine type, operating a throttle valve placed upon the gas inlet pipe. All the earlier gas engines were governed in this way, as engineers had not discovered that the limits within which gas and air can be mixed and still explode were very narrow. When governing, and running without load, the old Lenoir engine used to throw away about three-quarters of the gas which it used at full power.

Figure 2 is a diagram from a Lenoir engine of 1 h. p., in which the cylinder was 8⅓ inches in diameter, the piston having a stroke of 16¾ inches. The maximum pressure, in this diagram, is 48 pounds absolute, and the average pressure available throughout the stroke was about 8 pounds per square inch. The engine made 50 revolutions per minute, and indicated only 2 h. p. at that speed. This was the large gas engine of 1866, and the result was miserably poor, both as to total power for dimensions and as to economy of gas. The consumption was about one hundred cubic feet of gas per h. p. per hour.

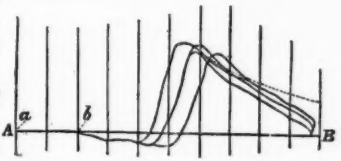


FIG 2. LENOIR ENGINE DIAGRAM.

At the time of the introduction of the Lenoir engine the most extravagant ideas were entertained as to its economy and power. For example, it was stated in Paris, in a journal called *Moigno's Cosmos*, that a 1-h. p. engine consumed 3 cubic meters of coal gas in twelve hours' work,—that is, nearly 106 cubic feet,—the cost for fuel, therefore, being no more than half that required by the steam engine. The actual consumption was much nearer 3 cubic meters per indicated horse per hour, than per twelve hours. The Otto and Langen engine was a great improvement upon this in point of consumption; it gave a brake h. p. on about 30 cubic feet of gas.

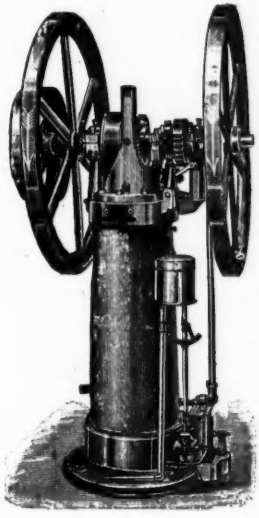


FIG. 3. OTTO AND LANGEN ENGINE.

In a 2-h. p. engine tested by me, 2.9 h. p. was indicated, and gas was consumed at the rate of 24.6 cubic feet per indicated horse power hour.

The Otto and Langen engine was the large power engine of 1876, and is shown at Figure 3. This engine consisted of a tall vertical cylinder surrounded by a water jacket. In it worked a piston, which carried a rack instead of a piston rod. The mouth of the cylinder was open to the atmosphere; across the top of the cylinder was carried the fly-wheel shaft, on which there was a toothed wheel engaging with the teeth of the rack. The wheel ran freely,

on the shaft when rotated in one direction, while the piston was on its upward stroke; then, by an ingenious arrangement, it gripped the shaft when the piston made its downward stroke. The shaft, therefore, was free to rotate continuously in one direction, notwithstanding the alternately-opposing movement of the toothed wheel running on it. While the piston moved up, the toothed wheel ran freely in the direction opposed to the movement of the shaft; when the piston moved down, an ingenious clutch arrangement within the toothed wheel came into operation, and caused the wheel to grip the shaft. This enabled the piston to give an impulse to the engine. The action was very peculiar. The piston was shot up in the cylinder by the explosion; the pressure rapidly fell by expansion, and soon reached atmosphere; the piston, however, had been moving rapidly, and had done no work; all the energy developed by the explosion had been given to it as motion, and it therefore moved on, the pressure beneath it falling below atmosphere, until all the energy of motion was absorbed in forming what engine makers have always called a vacuum. The outward flight of the piston then ceased, and the external atmospheric pressure drove the piston back. The actual work, therefore, was done by the atmosphere on the down stroke, and the explosion was spent in obtaining energy in a form conveniently applicable.

I first saw a specimen of this engine—3 h. p.—in a joiner's workshop in Glasgow, in 1876, and was much struck with its ingenuity, and also with the great noise and recoil caused by each explosion.

Steam engineers were then contemptuous of this "atmospheric" engine, as the only commercial gas engine then in use was called. It was, as has been shown, an economical engine for the time,—an enormous improvement on the Lenoir and like engines of earlier date, consuming not more than one-third as much gas for a given power. The whole mechanical arrangement of the engine, its action and balance, was revolting to the mind of the properly-constituted engineer. Successful engines have always been both quiet and simple, and the Otto and Langen was neither. It served its purpose, however, and demonstrated the possibility of obtaining, with some economy, motive power from gas by explosion, and many hundreds were made and used.

The inventor, the late Dr. Otto, of Cologne, was a very ingenious and determined man. Originally a schoolmaster, he became fascinated with the gas engine about 1860, and, being untrammeled by engineering tradition, struck out in the Otto and Langen a successful, though ugly, method of obtaining economy. Throughout the vogue of the atmospheric engine he appeared bent on producing something better,

and many of his patents show that he tried varying lines of work, generally failing. In 1876, however, he produced for the first time a successful compression gas engine,—that is, an engine in which the gases to be used were compressed before explosion. This idea was a new one, but to Otto belongs the credit of being the first to clearly see the difficulties to be overcome in carrying out the compression idea, and he originated the present Otto engine or Otto cycle, which has so far proved overwhelmingly the best. This is shown by the fact that, when the Otto patent expired in 1890, practically all the makers of gas engines throughout the world abandoned every other cycle of operation, and adopted the Otto cycle, so that now every gas engine made in Britain operates on the Otto cycle. The expiry of the Otto patent in 1890 had a most important effect on the gas engine from a commercial point of view. So many engineers devoted attention to the engine that the selling price rapidly fell, and now the first cost of engines to the user is only one-half what it was in 1866. This greatly increased the number of small gas engines in use by bringing the cost within the means of many small manufacturers.

It might have been anticipated that the lapse of the Otto patent and the competition among engineers would speedily lead to the production of large gas engines. This was to some extent undoubtedly the case. Larger gas engines are now made than hitherto, but their adoption has proceeded with somewhat disappointing slowness. Difficulties have been encountered in their construction and working which were not obvious to most engineers. A few engineers, no doubt,—the writer included,— *did* foresee many difficulties in the construction of large gas engines on the Otto cycle. These difficulties are now thoroughly well understood, and have been duly met in engines up to about 200 i. h. p. Attempts have been made to build the engines of greater power than this, but, so far as I am aware, these attempts have not been successful. Engines have been made and sent out for powers as high as 400 h. p., but I have been unable to obtain trustworthy details of their performance, and accordingly reserve judgment. I do know, however, from personal experience, that engines indicating 200 h. p. are now practicable and in successful operation.

The first gas engine of the Otto "silent" type, as it was then called, was put upon the market by the Messrs. Crossley in 1878. This engine was 3½ h. p. nominal, 6¾-inch cylinder, 12-inch stroke, 160 revolutions per minute. An engine of this power tested by me at that time gave 4 brake h. p. and consumed about 33 cubic feet of Manchester gas per brake h. p. per hour.

Very speedily larger engines were introduced; at the Kilburn

Royal Agricultural Society's Show, in 1879, Messrs. Crossley exhibited a 16-h. p. gas engine which was much admired by engineers as rather stupendous. Engineers and the engineering journals referred to this engine as the "King of Gas Engines." For several years this was the large gas engine.

No further great increase in size occurred until about 1888, when the hot tube igniter began to displace the old, ingenious, but troublesome, slide-valve flame igniters.

In 1889 a gas engine of 100 i. h. p was exhibited at the Paris exhibition by MM. Delamere-Deboutteville & Malandin, which they called the "Simplex Engine." This engine operated on the Otto cycle, was fired by the electric spark, and was started by a self-starting gear.

From 1889 to the present time, therefore, the advance has been from 100 to 200 i. h. p. Indeed, no great number of large engines have been made.

At the present time the total production of gas engines in Britain reaches about 100 per week,—that is, about 5,000 per year. The average power of these engines is about 20 horse, which makes the aggregate power of gas engines annually manufactured in Britain about 100,000. Of these engines Messrs. Crossley turn out sixty per week. The number of large gas engines, however, at present turned out from British workshops is comparatively small. The largest engines made by the Messrs. Crossley are double-cylinder engines, with opposed pistons acting by their connecting rods on a common crank placed between them. Two engines of this size have been supplied, and have now been at work for four years at the Blackpool Tower Co.'s establishment in Blackpool. These engines have been driving dynamos, pumps, and hoists. They are all 18½-inch cylinder and 24-inch stroke; they use coal gas, and run at 160 revolutions. They indicate 220 h. p. With producer gas, under similar conditions, they indicate 208 h. p.

Figure 4 shows one of these engines, which, as I have said, are the largest yet turned out by Messrs. Crossley. It will be observed that, when working at full power, the impulses succeed each other,—that is, one cylinder drives the crank pin in one direction, and the other cylinder continues the revolution, driving it on the other side of the circle. Then one complete revolution is necessary before any further impulses are obtained. It seems at first sight that, if two Otto-cycle cylinders were to be used, the better arrangement would have been that of cylinders placed alongside each other, and acting on the same crank pin, so as to give one impulse for each revolution at full power, leaving only a half revolution without impulse. It has

been found in practice, however, that the best engine is produced by giving an impulse in each direction for one revolution, and missing an entire revolution. Such an arrangement provides a less equable application of power to the crank shaft, and requires more fly-wheel power; but it allows of a very convenient form of engine frame, taking up but little width-space, and the Messrs. Crossley have found it most suitable for large powers. In the engine illustrated it will be observed that a rotating centrifugal governor is used, and that this governor is driven from the crank shaft directly, instead of, as in the older Crossley engines, from the valve shaft. This has been found necessary in large engines because of the very considerable torsion of the valve shaft when in operation. A large exhaust valve, say, four or five inches in diameter, even with a pressure of only 40 pounds per square inch above it at the moment of opening, requires a

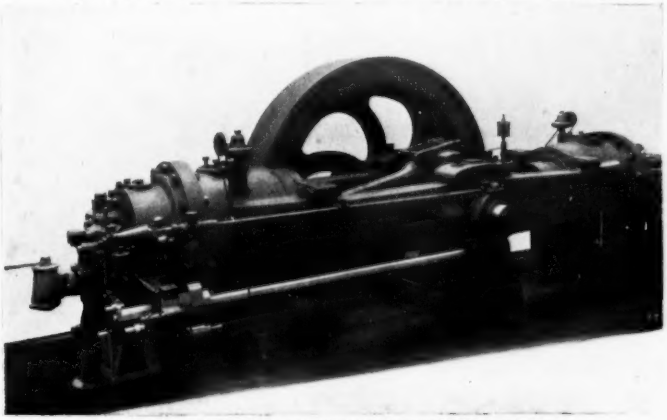


FIG. 4. LARGE DOUBLE-CYLINDER CROSSLEY ENGINE.

very considerable force to lift it, and this, when transmitted by a lever and roller to the cam on the valve shaft, produces in it a considerable torque. This has the effect of considerably varying the speed of the governor at different points of the revolution of the shaft, and so causes the governor to lag behind, and then suddenly pull off the wheel or knife-edge operating the gas valve. In this way half charges were sometimes given. Half charges of gas and air act very prejudicially in any engine, but are especially objectionable in a large engine, because of the irregular firing and back ignitions produced. The valve gear of the engine is very clearly seen in the illustration. The igniter is of the incandescent-tube type, in which a porcelain tube is used, and the mixture admitted to the tube by a

timing valve. The engine operates on the usual Otto cycle, and is started by a high-pressure starter used by the Messrs. Crossley under Clerk's patent.

Figure 5 shows a smaller double-cylinder engine of 60 nominal h. p., of Messrs. Crossley's construction, coupled to a Siemens dynamo. This engine indicates 188 h. p. with coal gas, and 165 h. p. with producer gas. The details are practically the same as those described with reference to the larger engine.

Figure 6 shows a 30-h. p. (nominal) electric-light engine, which, running at 230 revolutions, indicates with coal gas 118 h. p., and with producer gas 104 h. p.

Figure 7 shows a single-cylinder Crossley engine connected directly to a centrifugal pump. The engine is one of 40 h. p. (nominal), and gives, when running at 210 revolutions per minute, 120 brake h. p. It will be observed that in this cylinder only one

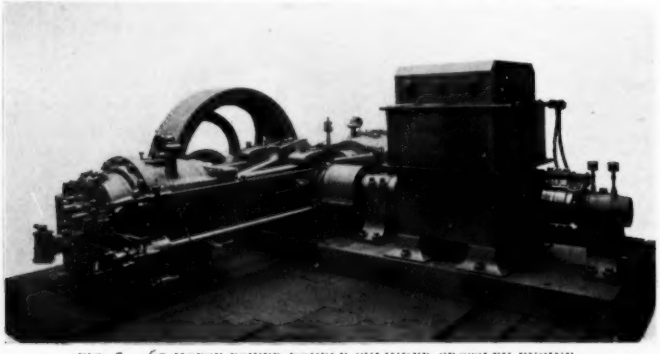


FIG. 5. 60-HORSE-POWER DOUBLE-CYLINDER CROSSLEY ENGINE.

fly-wheel is keyed on the engine crank shaft, the other being carried on the outer end of the pump shaft. The pump shaft and the engine shaft are strongly coupled. This engine is at work pumping out graving dock No. 2, belonging to the river wear commissioners at Sunderland. The speed of the engine and pump can be regulated within a wide range to suit the varying head against which the water is delivered by means of the adjusting screw on the engine governor, and I am informed that at a recent trial the engine emptied the dock in less than the specified time, running at only 180 revolutions per minute. This engine operates with coal gas.

The largest single-cylinder engine built by the Messrs. Crossley is a 50-h. p. (nominal). It indicates 140 h. p. with coal gas, and 130 with producer gas.

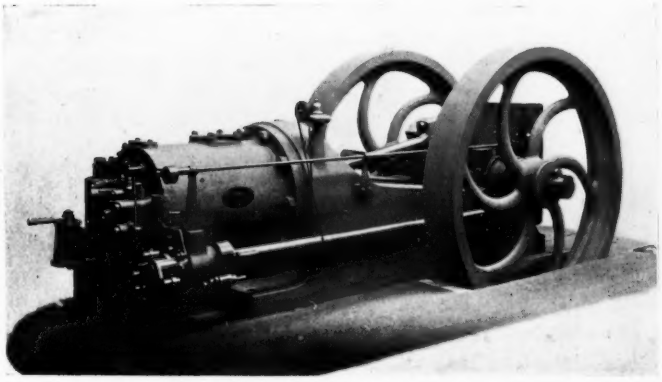


FIG. 6. 30-HORSE-POWER (NOMINAL) ELECTRIC-LIGHT ENGINE.

Altogether, they inform me, the Messrs. Crossley have at work two of the 80-h. p. (nominal) engines, each giving, as I have said, 220 i. h. p., and ten single-cylinder gas engines, each indicating about 140 h. p. Of these engines some have gone to Messrs. Sir John Brown & Co., of Sheffield, The Horsley Iron Co., of Tipton, and R. Cragg & Sons, of Middlesborough. Among the 60-h. p. engines three are in operation for the London county council, pumping water. The Messrs. Crossley thus appear to have delivered about thirty engines which may be called large,—that is, engines of considerably more than 100 i. h. p.

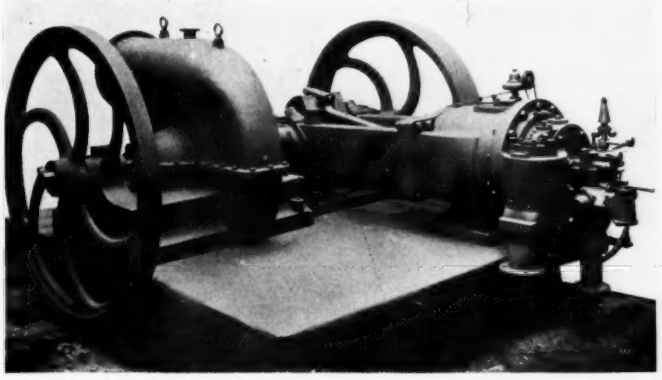


FIG. 7. SINGLE-CYLINDER CROSSLEY ENGINE DIRECT-CONNECTED TO CENTRIFUGAL PUMP.

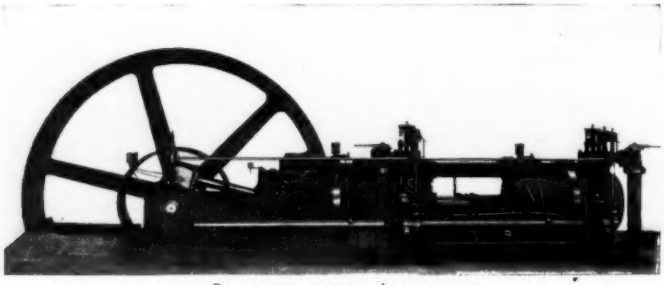


FIG. 8. WELLS BROTHERS' GAS ENGINE.

The Messrs. Tangye also have turned out a considerable number of large gas engines in the sense of the definition adopted herein, that is, engines equalling or exceeding 100 i. h. p., and two of these engines are running in the works of Messrs. Kynoch, of Birmingham, the well-known ammunition manufacturers, operating brass rolling mills for preparing cartridge metal.

This does not, of course, complete the record of progress. Besides the manufacturers whose types have already been illustrated, many other English makers have produced large engines,— Messrs. J.

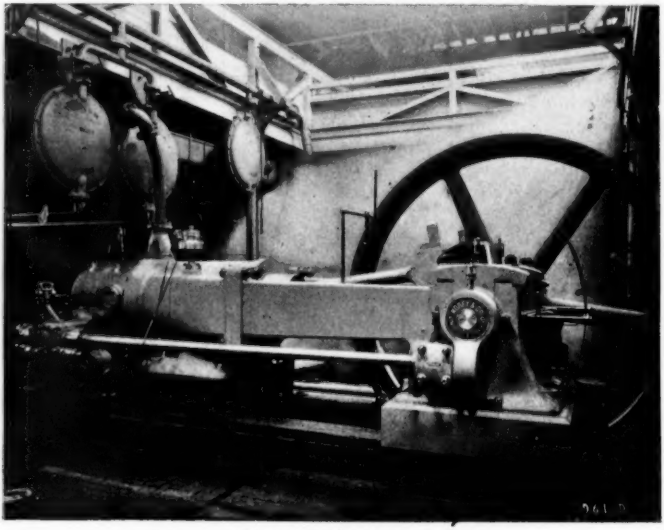


FIG. 9. MESSRS. ROBEY'S LARGE GAS ENGINE.

E. H. Andrew & Co., Dick Kerr & Co., Fielding & Platt, Wells Bros., and Robey & Co.

Figure 8 shows an engine indicating 200 h. p., built by Messrs. Wells Bros. This engine is of the tandem type. Two Otto cycle cylinders are arranged in line. One crank is used, and side rods pass to a crosshead connected to the front piston. These work a crosshead which operates the rear piston. In this engine an impulse is given at each forward stroke. Part of the forward piston is expanded, producing an annular cylinder, which is used as an air pump to supply air for scavenging or discharging the exhaust gases from both cylinders. Messrs. Wells Bros. have turned out three of these engines. They inform me that they have also made several single-cylinder engines, some of them giving more than 100 h. p. Altogether, they have turned out some thirty engines giving more than 50 brake h. p.

The largest engine made by Messrs. Robey gives nearly 100 i. h. p. It is shown in Figure 9. I am informed by Messrs. Robey that one of this size is now at work at Messrs. Luke & Spencers, Ltd., Broadheath, near Manchester, and that it operates on 1¾ pounds of coke per horse power, including the coke burned during the night to keep the producer in form. These engines are the typical large gas engines of the present time.

From this account it will be seen that, as yet, the number of large gas engines in use is small. In my opinion, the total number of gas engines built up to the present in Britain, giving more than 100 i. h. p., is less than one hundred.

Considering the great advantages of these engines over steam engines in respect of economy in fuel-consumption, it is somewhat remarkable that there should be so few; but a closer study of the problem at once reveals the reason. A large gas engine, such as that built by the Messrs. Crossley, called 80 h. p. (nominal), will run at full power on a consumption which may practically be taken as one pound of anthracite fuel per i. h. p. hour. The same engine with a Mond producer would consume only about one pound of common engine slack per i. h. p. hour. This is roughly about one-half the fuel consumed by the best steam engines of equal power, and it seems that in these days of intense competition so enormous an advantage in the fuel bill would speedily displace all steam engines.

So far we have considered the early types of gas engines, and reviewed the progress up to the present time. In a second article, which will appear in the February issue of THE ENGINEERING MAGAZINE, I shall consider the leading difficulties in the problem as they now present themselves, with a view to aiding engineers in their solution.

COST-KEEPING METHODS IN MACHINE-SHOP AND FOUNDRY.

By Henry Roland.

IV.—PROBLEMS OF GENERAL EXPENSE AND FIXING OF SELLING PRICES.

HAVING, in the preceding papers of this series, detailed some attempts at prime-cost reduction, the subject of total cost, or selling or "estimate" prices, follows in natural sequence.

Every machine builder not operating under a patent or the rare condition of some special production carrying so high a reputation in connection with the shop name as to deter competition must sell in the open market at prices very little above those of his rivals. If a builder, say, of steam engines or heavy lathes has an inquiry from a possible customer, he is perfectly aware that every other well-known builder of such work is in receipt of the same letter, and that, to have the order finally filled at his own establishment, he must quote a price not very much above what other makers of equal reputation will offer. He therefore desires to fix a price as close as possible to a fair living advance on the actual cost of the tool to himself or to his establishment, and, if the price is to be named with any degree of certainty, he must first know the probable total cost of the machine, this probable cost being made up of the prime-cost augmented by the proper share of the general expense with which this particular unit of production may be justly chargeable.

Salaries of non-producers, rent, taxes, interest, depreciation of plant, advertising, travelling, and collection of accounts go to make up a very large total expense account, some part of which will be directly chargeable to the production on which a price is to be fixed. What shall that proportion be, and what are the causes and conditions which determine the share of the expense account with which this particular article is justly chargeable?

Reference to relations of prime-cost and expense for a series of years shows that these relations are subject to large variations; in the busy years the volume of the prime-cost account is greater in proportion to the expense, and in dull years it is less. Perhaps in a good year the prime-cost total will greatly exceed the expense total, while in a dull year, with the same class of work, the expense total will largely exceed the prime-cost total, and the percentage of expense to be justly added to each dollar of prime-cost will vary accordingly.

It thus becomes clear that the actual future cost of a machine can

never be known. The probable prime-cost can be determined with an approach to accuracy, but the expense percentage which this prime-cost total should carry is always a matter of assumption, and can be based only on the past.

In most cases, it is safe to say, it is an assumption pure and simple, based on previous assumptions the accuracy of which has never been fully determined; and, when it is known that one concern may add as little as 30 per cent. to the prime-cost and assume the total to represent the total cost of its product, while another may make the increment as much as 150 per cent., it is at once apparent that between such extremes there lies a wide field, any portion of which may be occupied by erroneous prime-cost figures.

In point of fact, no manufacturer or constructer can ever know the exact cost of any single article of his own production, because the cost factors include so many variables that in no two instances is the cost of two similar pieces or machines exactly the same. Fortunately it is not essential to business success that precise first cost of the selling product of a metal-working establishment should be known in every individual instance. Business existence and success is, like every other existence in this world, a matter of averages, and it is enough for the foundation of a thoroughly systematic conduct of shop matters that the manager should have a fairly correct approximation to the average cost of his product. Again, it is probable that no machine builder ever knows the exact cost of any machine he makes, because an attempt at precision would entail an expense far beyond its possible gain.

The obtaining of exact foundry costs is, on the face of things, more difficult than the fixing of machine-finishing costs, as the foundry cost involves a multitude of obscure factors, or elements which can be made to appear obscure to some minds. Hence, perhaps, has come the quite erroneous practice in some establishments of charging all foundry labor directly to expense, laborers and moulders alike, assuming that the moulder's labor is so small an item as to be neglected without detriment to practical accuracy. So slipshod a method does not preserve sufficient detail of expenditure to enable the formation of estimates of such accuracy as is required in competing bids for work. The prime-cost and total cost of castings should be estimated by the method used for machine work.

The general problem of total-cost estimating is perfectly simple when the prime-cost and expense totals are known, because the whole expense must be added to the respective prime-costs, so that the sum of the total costs shall equal the sum of the prime-costs and the expense. Simple as this procedure seems, it can be complicated in

many ways, and may even be viewed in such lights as to leave certain large items of the expense account out of the total-cost estimates.

In point, total-cost estimates, as made by several large and carefully-regulated establishments, do not include interest on the value of the plant. This is a most unwarrantable omission. If the plant were rented, the rent would undoubtedly be included in the expense account and duly distributed as a part of the total cost of the machines built. Again, if the plant were sold, and its value in cash loaned, the lender would expect to receive interest on the amount, as a matter of course. Viewing the shop or plant as an individual entity transacting business for itself, the case is the same; the plant carries an indebtedness to some one, equal to its cash value, present or original. This indebtedness is necessitated by the creation of the plant, and interest on this amount is certainly a part of the general expense account, so long as the indebtedness exists. This indebtedness can be cancelled only by the earnings of the shop above total expenses. Profits of operating the plant might be credited to the shop, until this indebtedness and interest were cancelled and the original investors in the concern had their money back again. In this case the shop would own itself and be in debt to no one, and the interest charge would rightly disappear from the general expense account, but, until this establishment-cost is liquidated in some way, the interest charge in the expense account is certainly legitimate.

At the Pond shops it is maintained that the cost of plant is an investment, a gambling stake made by the founders of the establishment and so owing nothing to anybody. These premises are correct; the cost of a metal-working plant is a venture on the chances of business fluctuations, and is often totally lost; but it is not clear how this condition of risk extinguishes the inherent earning power of the capital invested, and, if the shop cannot pay interest on its cost, then this interest must remain a charge against an insolvent debtor.

At the Sellers establishment interest on the value of the plant is charged into the general expense. At the Brown & Sharpe shops it is not so charged. The Brown & Sharpe plant is valuable, having about six and one-half acres of floors on eleven or twelve acres of ground near the business center of Providence, Rhode Island, the buildings costing perhaps $2.50 per square foot of floor surface, and the tool equipment being very large and costly. In one cabinet on the Brown & Sharpe gear-cutting floor there are about nine thousand dollars' worth of gear-tooth mills for shop use, and the plant throughout is furnished in a commensurate manner.

Obviously, if an interest charge on the value of this magnificent plant were added to the general expense, it would make a material

difference in the percentage added to prime-cost to obtain the total cost; and the same is true of the Pond shops, where the buildings and tools are excellent.

At the De La Val shops the cost per square foot of floor is only about seventy-five cents, while at the fine steam-engine shops of Mackintosh & Seymour, Auburn, New York, the square foot of floor costs only about half a dollar; it is manifestly absurd to say that such differences should not be recognied in the total-cost estimates.

Strange as it may appear, there is also a difference in American shops over the question of depreciation of buildings and machine-tools. The Pond practice ignores plant depreciation, saying that their buildings and tools are thoroughly well kept up, and are to-day in every way as valuable productive factors as they ever were, and that, since the up-keep goes into the general expense, no other charge can justly be made. At the Brown & Sharpe shops a depreciation charge is made of 2½ per cent. on buildings and 5 per cent. on tools. There is also a material difference in the practice of various shops as to the inclusion of machine-tool deterioration in the expense account. Suppose the Brown & Sharpe figure of 5 per cent. is accepted as correctly representing the first year's loss of value on a machine tool costing $1,000, the tool will have a value on the inventory of $950 at the beginning of the second year. Then comes a question as to whether the depreciation for the second year shall be $50, or shall be 5 per cent. of the second-year value, $950, making the decrease in value only $47.50. This difference is material; as in the first case the whole value of the tool is extinguished in twenty years, while in the second case the tool would continue to appear as an asset forever, with a value constantly decreasing, but never lost.

In point of fact, it appears that machine-tool effectiveness does not decrease where the up-keep is as thorough as it certainly is in, say, the Pond, Sellers, and Brown & Sharpe shops, these being all machine-tool-building establishments. But there is always the advance of the art to consider; a machine tool may be as good to-day as it ever was, and yet stand so far behind the most recent tools of the same class in efficiency that it cannot be used at all by an economical manager, and hence has no shop value whatever, though it may still be so good as to find a ready purchaser at a considerable price. It is evident that, in this view of the case, the value of standard machine tools is constantly decreasing, and that such a charge for depreciation should be made yearly as will, when added to the price obtainable for the tool at a second-hand sale, equal the original price, with interest, to the day the well-kept-up antiquated tool goes out of the shop to be replaced by a more efficient modern creation.

Tools and fixtures, when made for a special job, are usually charged to the job as expense on that particular work, unless paid for by the customer under special contract. In some shops these special tools and fixtures are carried on the inventory as assets, but this is wrong, except in unusual cases. An old English law gave the English shop the ownership of all special tools and fixtures, even though designed and paid for by the customer. There may be such a law in the United States, but there it is the invariable practice to regard all special tools for which the customer pays as his property, of which he may take possession at will. An expensive lot of special tools held by the shop would be pretty sure to control future orders for the same job, and, under the probability of future orders, special tools and fixtures might become very valuable assets, as ensuring future profitable contracts. American practice generally charges all special tools and fixtures to the job for which they were made.

In the foundry, standard patterns well kept up are an asset, all repairs being charged to expense, and an interest charge on original pattern cost going to the expense account. Flasks go to the expense account, and can be carried on the inventory only at nominal figures.

These special items of the expense account are referred to as showing different ideas of cost keepers, and indicating the errors through which certain systems of total-cost keeping can be made to show a total production cost so low that at selling rates the shop should be making large profits while, in fact, it is continually losing money,—an error which can easily lead to underselling rivals until unexpected bankruptcy winds up affairs.

It seems very clear that every penny which has been or is being expended in or for any part of a machine shop or any other manufacturing business must represent a credit to some individual or account, and an equal indebtedness to some other individual or account, and can never be properly neglected until returned from some source to the original owner, because, in ordinary business, nothing except payment can extinguish a debt. If this assumption is correct, then the total original cost of the shop and the ground used by the shop is an interest-bearing debt, and the interest thereupon is an item of expense. The gain in ground value, if any, is an asset, and is sometimes, in the case of American shop properties, so great as to extinguish the whole debt for the plant in a few years; but, until the business is closed and the realty is sold and paid for, an interest charge on the realty value must go to the expense account, and until the realty value and interest thereupon are paid out of the profits of the business, there can be no just credit on the shop books for the advance. The shop takes all, and must pay all before it can make a profit.

This seems an incontrovertible proposition; yet many large establishments deny its truth, thus making their total cost estimates fall below what they actually should be. It is but natural that a manager should wish to think himself as good a manager as his rivals, and hence able to sell his product as cheaply as others can sell theirs, and hence, perhaps, comes the fixing of expense-percentage additions to prime-cost such as will permit selling prices to meet the market.

On the face of things a high percentage of expense addition to flat cost seems to indicate extravagant management, while a low expense percentage looks like economical management; but management may not be the deciding factor in the case. For example, at the Providence Steam Engine Works the expense percentage is 75 per cent. of prime-cost or under, while at the Newton Milling Machine Works, Philadelphia, the expense addition is 15 per cent. on cost of material and 150 per cent. on labor-cost. On this bare statement it appears that work is conducted very economically by the Providence Steam Engine Company and very poorly by the Newton. The facts are that the Providence shop makes nothing but steam engines of standard construction, and has small or no travelling or advertising expenses, and only a very small force of non-productive labor, while the Newton builds largely on special orders requiring new drawings and pattern-making in each case, thus making each machine an individual construction and inevitably increasing the cost enormously.

Another point in dispute is the addition of an expense percentage to the cost of materials purchased from the outside. In some places this is not done; in other places it is done, the managers asserting that interest on cost from the date of payment, storage on the shop premises, inspection and handling, and inevitable losses through breakages and imperfections, fully justify such an addition to the purchase and freight costs, which is undoubtedly correct.

To sum up, the expense account should include all salaries and wages except such as appear on the producer's time cards and go to make up the prime-cost, including a fair recompense for the services of the owners themselves, interest on first cost of entire plant (realty and all), depreciation on buildings and tools, and, where the warerooms or selling offices are separate from the shops, all items of expenditure due to such separation. In estimating, a percentage on materials purchased should be added, and, in brief, every possible outlay should be considered. Then, if the establishment makes a low price because it wants work for its men or wants to keep work from going to rivals, the manager at least knows what he is about, and can correctly estimate his losses from the first. It often happens that work is taken below living rates, because the manager, having the choice of

two evils, accepts that which in his judgment involves the lesser detriment to himself and his establishment; but in this disastrous practice it is essential that he should not underestimate the damage to result from his policy.

As an exhibition of actual practice, the following estimate of founding costs is taken from the form of the Builder's Iron Foundry, which has always made large amounts of castings for sale:

1. Estimate fully time cost of core-makers, moulders, and helpers.
2. Estimate fully cost of pig iron piled in the yard, adding for waste 9.13 per cent.
3. Examine melting book to determine average cost per gross ton for the last four weeks; to this average cost add 34.2 per cent., which will make a total equal to the cost of melting each net ton, covering waste and remeltings.
4. For cartages add 88 cents per short ton.
5. Moulding materials equal 36.13 per cent. of producer's wages.
6. Foundry labor, $3.75 per ton.
7. Yard expenses, cleaning and shipping, $3.50 per ton.
8. Fixed charges. These will vary with number of producers,—*viz.*, moulders, moulder's helpers, and core-makers. The number of these men on the time book is taken as the base, as the average output per same number of producer's names is almost constant.

With 100 names in work, on order under estimate add for fixed charges 50 per cent. of total producer's wages.

For 90 names add 55.5 per cent.
" 80 " " 62.5 per cent.
" 70 " " 71.5 per cent.
" 60 " " 83.33 per cent.
" 50 " " 100 per cent.
" 40 " " 125 per cent., and
" 30 " " 166 per cent.

As the Builder's Iron Foundry pays great attention to turning out heavy loam work, these figures are worthy of especial attention from a commercial point of view, or, in other words, may be regarded as giving direct information of commercial value to other firms in the same line. Some other establishments refused their actual addition percentages on this very ground that the giving of these percentages would be of assistance to their competitors, while in the same breath lamenting the want of correct knowledges which led those competitors to often fix selling price below living rates. All American manufacturers of metal work who were seen in this connection were emphatic in their statements that it would be of great benefit to all concerned if correct information were supplied, leading to the fixing of correct

total-cost and selling-estimate figures; but some refused the disclosure of their own percentages.

In general terms, the larger the force of hands working, the smaller the percentage of expense to be charged against the labor of each. Thus the percentages at the Builder's Iron Foundry range from 50 per cent. when one hundred moulders are at work to 166 per cent. for the minimum number of thirty hands.

So, again, the dividing of a shop into a great number of different departments increases the expense, although in certain cases this increased expense is more than returned in increased production.

The Yale & Towne Foundry costs are very accurately kept by use of a form which details the piece-cost as well as the weight-cost. This form is given below, and, as shown by the column headings, it enables a detailed tabulation to be made of the prime-cost of each article.

THE YALE & TOWNE MFG. CO.

COST OF IRON CASTINGS.

Date.	List No.	Article.	Per Flask.			Rates.	
			No.	Lbs.	Oz	Molding per Flask.	Core-Making.

LABOR COST PER LB.						COST PER LB. OF	
Molding.	Core-Making.	Melting.	Finishing.	Annealing.	Total.	Metal Melted.	Material, Molding, Anl'g and Fin'g

PERCENTAGE.		COST PER LB.	WEIGHT OF ARTICLE.	CASTING COST PER PC.
For General Expenses.	For Bad Castings.			

Account is taken of the minor details of moulding, recognizing

the great difference in cost between castings having little weight per flask and those which enable a considerable weight of metal to be poured in each. The moulding per flask and the core-making are piece-rates, and the melting, finishing, and annealing are percentages. Examination of some of these Yale & Towne castings-cost sheets convinced the writer that they exhibit a very close approach to accuracy in cost per pound and piece. The actual percentages used in calculating those items not obtained from time- and piece-work records could not be obtained of the Yale & Towne shops for publication, and would not be of value if they were printed, since they would not agree with the practice of other American shops, and certainly no other shop seeking such details of cost would assume the Yale & Towne percentages for their own. With the same number of hands in work and the same grade of product and standard of inspection, the prime cost of castings is surprisingly uniform in different shops. But, if the standard of inspection is raised, the cost of product must increase out of all proportion, seemingly, to the increase in rigidity of inspection.

This is true both of finishing and founding. In a recent case two sixty-inch lathes were built together, one with ordinary accuracy, and the other with a small inspection limit, the latter costing twice as much for labor as the ordinary commercial tool.

This increase of cost seems almost incredible, but it was in this case the unpleasant fact, and estimates must take notice of any specifications calling for unusual accuracy of construction in machine work, or an uncommonly fine surface in castings, owing to the enormous increase in total cost which is thereby certain to accrue. Thus in the Yale & Towne shops iron castings which, so far as size, weight, and stock were concerned, could be contracted for outside at 3 or 3½ cents were costing 6 and 7 cents in their own foundry, simply because of the fine skin and entire freedom from imperfection demanded.

EUROPEAN SYSTEMS OF HOUSE-HEATING.

By J. L. Saunders.

HOUSE-HEATING practice in Great Britain, when compared with that current in America, exhibits great differences in style of apparatus employed, in the systems in favour, and in the extent to which the development itself has proceeded.

Some of the reasons, at least, are very apparent. In a large portion of the United States and throughout Canada, the winter climate is such that some artificial heat, over and above that obtainable from an open fire, is absolutely necessary; in Great Britain, however, the old-fashioned open fire-place is, as a rule, sufficient, or, at least, has been so considered until very recently. Within the last few years there has been a growing appreciation, among the British people, of the comfort and advantage of maintaining an even temperature throughout an entire building, whether this be a dwelling or a school, church, office-building, or other *quasi*-public edifice. Indeed, even in private dwellings, where it is most attractive and most nearly adequate, the open fire, if depended on entirely, too often gives one the choice between being partly roasted, if he sits near, or shivering, if he moves to the further corners of the room or passes to the halls and staircases.

While the severity of the American climate has been of itself sufficient to cause the great demand for heating apparatus, there is at least a general belief that the climatic effect on the human system creates a greater dependence on artificial warmth among Americans than among Englishmen. The blood seems to become thinner. It was my own experience that, when I first went to America, I could well endure the cold, and the temperature of 70° usually maintained in buildings there was far too warm for me. As years went by, I grew more and more sensitive to the cold, and, on first returning to England, I felt the temperature of 60° maintained in English houses quite too low; but in a short time I became re-acclimated.

Again, the large blocks of buildings erected in America demand efficient adaptation of the heating apparatus, for it would be almost an impossibility to heat these large buildings (no matter what their use) by open fires. Fancy the large coal-storage space that would be necessary, and the work and labour of carrying coal to and ashes from all the different rooms, and of cleaning and attending to all these fires; the cost would be tremendous. In fact, one of the strongest economic principles in America is labour-saving; and an

efficient heating apparatus is a labour-saver as well as a money-saver.

By a natural retroaction, the general introduction of improved house-heating systems, which primarily stimulated manufacturers to increased effort toward the production of efficient and economical apparatus, has itself received an impetus from the lowered cost and increased convenience of the many devices now offered in the market.

There is no doubt that America is now far in advance of Great Britain, in its systems of heating apparatus, and the materials and methods used in their installation. Many years ago the mode of heating was as crude in America as, I am sorry to say, it often is now in Great Britain; but, as time went on and the demands became greater, natural competition proved to be, as always, the greatest producer of improvements; every keen competitor was anxious to have the latest device, style, system, or material, to assist him in obtaining a contract. For example, the hot-water or low-pressure steam boilers generally employed in America are, as a rule, far in advance of those in general use in Great Britain. This great advance has come about within the last fifteen or twenty years.

One of the principal points for which the manufacturers have striven was to produce a boiler that would give the maximum amount of heat for the minimum consumption of fuel, the cost of fuel being a great consideration in America. And as every manufacturer was anxious to produce the best boiler, it is natural that the questions of grate-surface, fire-surface, and rating of a boiler should have been carefully studied in America. Other points receiving especial attention have been the manner of constructing the surfaces in the boiler so that they will absorb the utmost of the heat of the gases before they pass into the chimney; simplicity of construction; easiness of erection; getting them into the building required to be heated; cheapness and simplicity of repairs; and facilities for firing and keeping clean. From the combined results of all this study the modern American boiler has been developed. In Great Britain all these important factors in the construction of a boiler seem, as a rule, to be but little studied. The average English boiler seems to be constructed with but little consideration for the amount of fuel it will consume, and its grate and heating surfaces seem to be proportioned, not according to any set rules or ratios, but purely by guesswork. Many a boiler manufacturer of Great Britain, if asked the size of the grate-surface or fire-surface of his boiler, or its rating in proportion to its grate- and fire-surfaces, would look in astonishment, and ask the purpose of the question. In many cases, indeed, he could not tell. With but very few exceptions, the boilers made in Great Britain are of wrought iron, either welded or riveted, and are made in one piece,

requiring to be brick-set. Almost invariably this setting is done according to the individual idea of each heating engineer or heating contractor. The boiler manufacturer does not have any particular design for setting the boiler bought from him. Thus it may be seen how vague are the statements of the rating of a boiler, as this depends a good deal on how it is set.

Nearly all the manufacturers make the same style of boiler, the only difference being that each has his own name. The only competition is in price. But within the last few years some manufacturers have begun to produce and push patent boilers of their own, using as strong arguments for their special type its advantages in construction, style, and heating-power in comparison to fuel-consumption. A few years will no doubt witness vast improvements in the boilers for heating systems in Great Britain. Most of the new boilers put on the market at present are of the American style, and do not require to be brick-set; they are called independent boilers, but they are made of wrought iron.

The British people are somewhat prejudiced against the cast-iron boiler, for just what reason it is hard to tell; no doubt one reason is that cast-iron boilers so far produced in Britain have been cast in one piece, have been very heavy because of the thickness of metal, and may easily be broken because of unevenness of expansion and contraction, as well as unevenness of thickness. It is asserted, also, that if a boiler is of wrought-iron made in one piece, there is less likelihood of leakage than in a cast-iron sectional boiler which has to be put together with many joints. This is a point open to discussion. Although there is this prejudice in England against cast-iron boilers, it is no doubt dying; I have used a number of American cast-iron boilers in recent contracts, and several firms are using and selling American cast-iron sectional boilers in Great Britain to-day. In fact, there is one English firm that is putting on the English market a cast-iron boiler of American manufacture, though sold under another name. Although the larger number of boilers in use in Great Britain are of wrought iron, either brick-set or independent, both classes show great variety in type, style, and mode of construction—especially in the arrangement of flues, cross tubes, and narrow flues. The greatest objection to the independent boiler is that, as a rule, it has no covering, and therefore is giving out a great deal of its heat where it should not. Indeed, the commonest fault with British boilers is that they are great fuel-consumers.

The low-pressure hot-water system is the one most largely used in Great Britain, but its chief application is to the heating of schools, churches, and public buildings; very few residences are

heated in any way except by the open fire-place, although of late years far more of the owners of large residences and mansions are putting in some one of the newer heating devices, using it, as a rule, as an auxiliary to the open grate, which holds its own because it ministers to the natural love of the sight of an open fire and the maintenance of good ventilation. Low-pressure steam is but little used, as it is often considered to give too high a temperature for the heating of buildings. Another reason may be that its installation is not well understood, some very bad results having been produced. The two-pipe system is used, and the principal trouble has been that the returns have not been properly taken care of, with the result that water hammer has run riot. The one-pipe system is but little known, and the British architect is rather a difficult person to convert to new ideas. There are a few firms in Great Britain which are now doing considerable steam-heating, using one-pipe work; and very good work indeed they are doing, for there is no question that, when the Briton goes in for good work, he does the very best. The fan system (or plenum, as it called in Great Britain) has only of late come into use, and only in large public buildings, but it bids fair to become prominent. It is installed in Great Britain in a manner somewhat different from that prevailing in America; more often than not low-pressure hot water is the heating agent, instead of steam. Instead, however, of making one large heating chamber, from which the warmed air is blown through tubes to the upright flues and thence to the different apartments in the building, the heating surface is subdivided, and the small units placed at the foot of each individual flue, and cased in. A brick tunnel leads from the fan around the building (under the ground floor), and from this tunnel the air is supplied to each stack of heating surface and regulated at the bottom of the separate flues. There are, of course, many ways of installing the fan system and of regulating the supply of warm fresh air and of taking out the foul air. Where low-pressure hot water is the heating power, a gas engine is used to draw the fan.

The high-pressure hot-water system (known as the Perkins system) was at one time very largely used in Great Britain, but of late is less often installed. In this system the boiler is simply a coil constructed of very heavy wrought iron pipe and incased in brick work. From this coil are run strong inch pipes with $\frac{5}{8}$-inch or $\frac{7}{8}$-inch bore. The circuit is generally continuous, with no valves and no means of shutting off any part of the apparatus; the heat must be either on or off for the entire building. In some cases, however, there are several circuits with valves and bye-passes to each circuit. The pipes are put together in a very strong manner, for they have to withstand a heavy

pressure. The joints are connected by right- and left-hand couplings. The joint is not made by tightening on the threads. The ends of the pipes are made one convex and the other concave, and the process of tightening the couplings butts the two ends of the pipe together. The same kind of joint is made with all fittings, and the fittings are all made of wrought pipe of heavy gauge; where bends (or elbows) are required, the pipe has to be bent by the use of a fire. The system is run at a very high temperature, and, as it is entirely sealed up with but a small air-chamber or air-cushion, the pressure is very great. The principal objection is the unevenness of temperature, caused in the following way. When the fire is on, the water does not circulate slowly, as in a low-pressure system, but stands still until a high temperature is reached, and then goes through the pipes with a rush; as soon as the fire drops, the circulation stops, and the heat soon dies down.

The use of hot-air heating in Great Britain is very small; in fact, about the only system used is the Grundy, and that principally in churches and schools. It is different from the practice in America, which commonly involves the use of a furnace with tin flues.

The systems of low-pressure hot-water heating in use are much the same in both countries, the three principal being the rising system, the drop system, and the one-pipe system. In the first, the flow and return are duplicates one of the other, and the mains run side by side, or one above the other, in the basement cellar or in trenches below the ground floor, branches rising from these mains. In the drop system, a main riser is taken to the highest point of the building, and a main run around the top of the building, and from this main are taken drop pipes which supply the heating surface on their way down, the flow and return to the coil, or radiator, being from the one drop pipe; then all the different drop pipes are gathered into a main return pipe below the ground-floor and returned to the boiler. The one-pipe system consists of one large main, in basement or cellar, which main is of the same size throughout. Its highest point is at its exit from the boiler, and it has a gradual fall all the way till it enters the return. This one pipe is used for both flow and return, the flow branches leaving the top and the return branches entering at its side.

Although the systems are much the same in both countries, they vary in detail; all three systems have been more fully developed in America. The rising system is most frequently used in Great Britain, the other two systems named being less often met, although I have put in several since my return to England. As to style of work, America is far in advance, but the large demand for heating and the great competition account for the superior quality of American work. The demand for heating systems has been comparatively small in

Great Britain, as the country has been satisfied to go on in its old lines; but, as the demand increases, improvements are made, and some very fine systems are now being erected. Indirect heating, for example, which until very recently was hardly known, has been introduced in several large and handsome residences, the work being of the very best class. The indirect stacks are incased in chambers constructed of the finest glazed bricks, so arranged that access can be had for cleaning. The registers are of solid bronze metal of Tuttle & Bailey's best manufacture. Several strong principles which have been allowed to govern the erection of heating plants in Great Britain have prevented the work from presenting the most pleasing effect. One of the most prominent is the prevailing use of cast-iron pipe, heavy and clumsy in appearance; it has to be adopted in many cases for the reason that the water is so bad that it destroys or fills up the wrought-iron pipes in a very short time. This has limited the demand for wrought-iron pipe, especially in sizes more than two inches in diameter; and, as a natural result, the prices of all the larger sizes are very high. No doubt to an American a very peculiar appearance would be presented by a heating job wherein the mains were of cast-iron pipe in lengths of nine feet, with spigot and socket joints caulked together with either rust joint, or red and white lead and spun yarn; nevertheless a great part of the work in Great Britain is done in this manner; again much of the heating surface is constructed of coils made of cast-iron pipe, two inches and upwards in diameter, put together in the manner described above. In greenhouse work cast-iron pipe is always used, and, as a rule, the joints are made with india-rubber rings, known as india-rubber expansion joints. Another point affecting heating plants in Great Britain is that comparatively few of the buildings have basements under the whole house; this makes it very difficult to get in mains, and the result is that the mains are made as short as possible, and the different rooms are heated by running long coils from room to room, making long circuits with short mains, to avoid very heavy expense in making channels, trenches, or tunnels below the ground-floor. At one time there were but few radiators in use in Great Britain, the heating surface being usually of cast-iron pipe and cast-iron coils; but now the public is beginning to desire them and architects to specify them. But the Briton has little desire for decoration. It is generally his request that the radiators be put out of sight as much as possible. There is no doubt that the heating business in Great Britain is improving very much, and that the class of work is growing better every year and patterning more after American practice; but no doubt it will be some time before buildings are heated throughout, and each room controlled by a thermostat.

THE TRANSMISSION OF POWER BY BELTS AND PULLEYS.

By C. L. Redfield.

THE tendency to seek after "some new thing," which is at least as old as literature and as strong in the department of mechanics as elsewhere, is perhaps in part responsible for the neglect into which the older methods of power-transmission have recently shown a tendency to fall.

Electrical, or, in proper situations, pneumatic, transmission exhibits so striking convenience and so marked economy that there is a not unnatural disposition to concentrate attention upon these methods, and to slight correspondingly the older means of belts and pulleys.

But these older and more peculiarly mechanical contrivances are by no means superseded; they must be largely employed even in connection with the newer agencies, and in a vast number of establishments will continue to be the sole dependence. Part, at least, of the disfavor with which they are sometimes regarded arises from the very unfair method of judging a system by its abuses.

Comparison of the several rival systems is too often made in forgetfulness of the fact that, in delivering power through belts, pulleys, and shafting, there are many elements to be taken into consideration. First, there is the diameter of the shaft, depending upon the power to be delivered and the revolutions per minute; second, the diameter and face of pulleys, depending upon the revolutions and belt-speed required or assumed; third, size of belt depending upon the force that must be delivered at the speed assumed. In ordinary cases these elements may be properly combined in an endless variety of ways, each of which would reach the required result, but with differing degrees of loss from friction. Any person who has had experience in a shop considers himself qualified to arrange pulleys and shafting so as to deliver any required power, but comparatively few know how to do so with a minimum of loss.

Before any rational effort can be made to reduce the losses in transmitting power through these elements, it is necessary to know where they occur and what causes them. They occur in the belts at the points where they bend around the pulleys, and in the journals of the shafts.

The first loss consists of the power required to bend and unbend

the belts as they pass on and off the pulleys. While the loss at this point is relatively small as compared to that occurring at the other, it is not altogether insignificant, as will be seen by the fact that it is continually going on at four places on each belt in use. Furthermore, reduction of loss of this kind is worth considering, because it costs nothing, and is all gain, not being accompanied by any attendant loss. To transmit a given amount of power, a certain number of cubic inches of belting must pass a given point in a given time. This may be accomplished by moving a large sectional area at a slow speed, or a small area at a high speed. In either case (or in any case) the product of the area multiplied by the velocity must not be less than a certain fixed quantity, the size of which depends upon the power to be transmitted. With the velocity fixed and the sectional area ascertained, we can obtain that area from either a thick and narrow belt or a thin and wide one. The force required to bend any body varies as the breadth, as the square of the thickness, and as the amount of the bend. For example, a belt two inches wide will offer twice as much resistance as another of the same thickness and only one inch wide, and a belt a quarter of an inch thick will offer four times the resistance of another only an eighth of an inch thick. Combining these two, we find that a one-inch belt a quarter of an inch thick is twice as stiff as a two-inch belt an eighth of an inch thick. As these two belts have the same sectional area and are consequently equal, it follows that less power (one-half) will be lost by running the thin belt instead of the thick one. As the loss also depends upon the amount of the bend,—that is, upon its sharpness,—and as the sharpness of the bend depends upon the diameter of the pulleys, it follows that pulleys of large diameter are more economical than those of small diameter. It is seen, therefore, that, as far as the belts themselves are concerned, the maximum of economy is obtained by the use of thin belts on large pulleys.

There is still another advantage in the use of thin belts and pulleys of large diameter, which, while somewhat vague and incapable of valuation, is none the less real. A thin belt, by virtue of its pliability, hugs the face of the pulley more closely than a thick and stiff one, and consequently will not slip so easily under a given load. To prevent any belt from slipping, it must have a certain tension on the slack side, the subtraction of which from that on the tight side leaves a remainder that represents the force transmitted. The sum of these two tensions represents the pressure thrown upon the journals of each of the two shafts connected by a belt, and it is this pressure that forms one of the elements of the loss at those points. For each pound of tension added to the slack side of a belt to keep it from slip-

ping another must be added to the tight side to overcome it, which two pounds, transmitted to the shafts, gives four pounds on the journals. It therefore follows that, for every pound removed from the slack side of a belt by reason of superior belt-adhesion, four pounds of pressure are removed from the friction surface at the journals. Pliability of belt and large pulley-diameter both tend to increase this adhesion, and thus to reduce the loss at points distant from themselves. For the same reason wooden pulleys are superior to iron ones, and leather-lagged pulleys, in turn, are superior to wooden ones.

The amount of power that can be delivered through a shaft varies as the cube of the diameter and as the revolutions per minute. Thus a two-inch shaft will transmit eight times as much power as a one-inch shaft at any given speed, and a given shaft will transmit twice as much power at two hundred revolutions per minute as it will at one hundred.

The loss from friction varies as the weight, load, or pressure on the journals, multiplied by the speed. Considering the shaft by itself, its friction-speed varies as the diameter, and its weight as the square of the diameter; consequently the loss from friction varies as the cube of the diameter. It is apparent, therefore, that, if the shaft carries no load but its own weight, it makes no difference what size is used, provided the speed corresponds to the size. In any shaft carrying a constant load other than its own weight, every change toward smaller diameter and greater number of revolutions increases the speed of the rubbing surface faster than the total weight on the journals diminishes, and there is consequently a loss; changing in the opposite direction will effect a saving. Usually the load varies when the speed varies, and in such cases the question of gain or loss depends upon whether the product of the load multiplied by the speed of the journal-friction is an increasing or a diminishing quantity.

A horse power is 33,000 foot-pounds, which is a force in pounds multiplied by the number of feet through which that force must move in one minute to produce one horse power. Thus, if the force is 100 pounds, it must move 330 feet per minute to make the product of the two equal to 33,000. Consequently, the faster a belt travels, the less pull it must exert to transmit a given amount of power. As several times this pull (whatever it may be) rests directly upon the journals of the shaft and becomes part of the load it carries, it is evident that high belt-speed is a potent factor in reducing loss by friction. The speed of belts may be increased either by increasing the revolutions of the shaft, or by enlarging the diameters of the pulleys, or by both.

It may be stated as a general truth that every increase of belt-speed serves to lessen the loss of power through friction; but, as the amount of gain gradually diminishes as the speed increases, and as other elements enter into the calculation at very high speeds, there is a practical limit, lying somewhere between 4,000 and 7,000 feet per minute, beyond which further increase of belt-speed results in loss rather than gain.

Increase of belt-speed by increasing the revolutions of the shaft is not all gain, because the load carried by the shaft moves a greater distance on its friction surface. So also there is an attendant loss connected with increase of belt-speed by increasing the pulley-diameters, because, while larger diameters may have less face, the weight increases with the increasing diameter faster than it diminishes with the diminution of the face.

To make this matter clearer, and also to show the effect of a series of successive changes, I have assumed certain conditions where power is to be delivered from a line shaft, and have prepared certain tables to facilitate the calculations. Table I gives the diameters of shafts

TABLE I.

Horse Power.	Diameter of Shafts. Revolutions per Minute.												
	100	125	150	175	200	225	250	275	300	325	350	375	400
1.....	1⅛	1	1	⅞	⅞	⅞	⅞	⅞	¾	¾	¾	¾	⅝
2.....	1⅜	1¼	1¼	1⅛	1⅛	1⅛	1	1	1	⅞	⅞	⅞	⅞
3.....	1⅜	1½	1⅜	1¼	1¼	1¼	1⅛	1⅛	1⅛	1⅛	1⅛	1⅛	1
4.....	1¾	1⅝	1½	1⅜	1⅜	1⅜	1¼	1¼	1¼	1¼	1⅛	1⅛	1⅛
5.....	1⅞	1¾	1⅝	1⅝	1½	1½	1⅜	1⅜	1⅜	1¼	1¼	1¼	1¼
6.....	2	1⅞	1¾	1⅝	1⅝	1½	1½	1½	1⅜	1⅜	1⅜	1⅜	1¼
7.....	2⅛	2	1⅞	1¾	1⅝	1⅝	1½	1½	1½	1½	1⅜	1⅜	1⅜
8.....	2⅛	2	1⅞	1⅞	1¾	1⅝	1⅝	1⅝	1½	1½	1½	1½	1⅜
9.....	2¼	2⅛	2	1⅞	1⅞	1¾	1¾	1⅝	1⅝	1½	1½	1½	1½
10.....	2⅜	2¼	2⅛	2	1⅞	1⅞	1¾	1¾	1⅝	1⅝	1⅝	1½	1½
12.....	2½	2⅜	2¼	2⅛	2	1⅞	1⅞	1⅞	1¾	1¾	1⅝	1⅝	1⅝
14.....	2⅝	2⅜	2¼	2⅛	2⅛	2	2	1⅞	1⅞	1¾	1¾	1⅝	1⅝
16.....	2¾	2½	2⅜	2¼	2¼	2⅛	2⅛	2	2	1⅞	1⅞	1¾	1¾
18.....	2⅞	2⅝	2½	2⅜	2¼	2¼	2⅛	2	2	1⅞	1⅞	1⅞	1⅞
20.....	3	2¾	2½	2½	2⅜	2¼	2¼	2⅛	2⅛	2	2	1⅞	1⅞
25.....	3¼	3	2¾	2⅝	2½	2½	2⅜	2¼	2¼	2⅛	2⅛	2	2
30.....	3⅜	3⅛	3	2¾	2⅝	2⅜	2½	2½	2⅜	2⅜	2¼	2¼	2⅛
35.....	3½	3¼	3⅛	3	2⅞	2¾	2⅝	2½	2½	2¾	2⅜	2⅜	2⅛
40.....	3⅜	3⅜	3¼	3⅛	3	2⅞	2¼	2⅝	2⅝	2½	2½	2⅜	2⅜

required for different horse powers at different speeds. Table II gives the belt-speeds, and the motive force that is required at each speed to produce one horse power. The upper figures are belt-speeds, and the lower ones are motive forces, and the product of any couple of them equals 33,000.

TABLE II.

Diameter of Pulley.	Belt Speed and Motive Force per Horse Power. Revolutions per Minute.												
	100	125	150	175	200	225	250	275	300	325	350	375	400
8	209	262	314	366	419	472	523	575	628	680	733	785	838
	158	126	105	90	79	70	63	57.4	52.5	48.5	45	42	39.4
10	262	327	393	458	523	589	654	720	785	851	916	982	1047
	126	101	84	72	63	56	50.4	45.8	42	38.8	36	33.6	31.5
12	314	392	471	550	628	707	785	864	942	1021	1100	1179	1257
	105	84	70	60	52.5	46.6	42	38.2	35	32.4	30	28	26.3
14	366	458	550	641	733	824	916	1007	1100	1192	1283	1375	1466
	90	72	60	51.4	45	40	36	32.9	30	27.7	25.7	24	22.5
16	419	523	628	733	838	942	1047	1152	1257	1362	1466	1571	1676
	79	63	52.5	45	39.4	35	31.5	28.6	26.3	24.2	22.5	21	19 7
18	471	588	707	825	942	1060	1178	1296	1414	1532	1649	1767	1885
	70	56	46.7	40	35	31.1	28	25.5	23.3	21.5	20	18.7	17.5
20	523	654	785	916	1047	1178	1309	1440	1571	1702	1833	1963	2094
	63	50.4	42	36	31.5	28	25.2	22.9	21	19.4	18	16.8	15.75
22	576	720	864	1008	1152	1296	1440	1584	1728	1872	2016	2160	2304
	57.4	45.8	38.2	32.9	28.6	25.5	22.9	20.8	19	17.7	16.4	15.3	14.3
24	628	785	942	1100	1257	1414	1571	1728	1885	2042	2199	2356	2513
	52.5	42	35	30	26.3	23.3	21	19	17.5	16.2	15	14	13
26	680	850	1021	1191	1361	1531	1701	1871	2041	2211	2382	2552	2723
	48.5	38.8	32.4	27.7	24.2	21.5	19.4	17.7	16.2	14.8	13.8	12.9	11.7
28	733	916	1100	1283	1466	1649	1833	2016	2199	2382	2566	2749	2932
	45	36	30	25.7	22.5	20	18	16.4	15	13.8	12.8	12	11.25
30	785	981	1178	1375	1571	1767	1963	2159	2356	2552	2749	2945	3142
	42	33.6	28	24	21	18.7	16.8	15.3	14	12.9	12	11.2	10.5
32	838	1047	1257	1466	1676	1885	2095	2305	2514	2724	2933	3142	3351
	39.4	31.5	26.3	22.5	19.7	17.5	15.75	14.3	13	11.7	11.25	10.5	9.83
34	890	1112	1335	1557	1780	2002	2225	2447	2670	2892	3115	3337	3561
	37.1	29.8	24.5	21.2	18.6	16.5	14.9	13.5	12.4	11.4	10.6	9.9	9.3
36	942	1178	1414	1649	1885	2120	2356	2591	2827	3062	3298	3534	3770
	35	28	23.3	20	17.5	15.5	14	12.7	11.7	10 75	10	9.37	8.75
38	995	1244	1492	1741	1990	2239	2487	2736	2985	3134	3482	3731	3980
	33.2	26.4	21.7	18.8	16.6	14.6	13.2	12.1	10.8	10.55	9.5	8.9	8.3
40	1047	1309	1571	1833	2094	2356	2618	2880	3142	3403	3665	3927	4189
	31.5	25.2	21	18	15.7	14	12.6	11.5	10.5	9.7	9	8.4	7.9
42	1100	1375	1650	1924	2199	2474	2749	3024	3299	3574	3848	4123	4398
	30	24	20	17.1	15	13.3	12	10.9	10	9.3	8.57	8	7.5
44	1152	1440	1728	2016	2304	2592	2880	3168	3456	3744	4032	4320	4608
	28.6	22.9	19	16.4	14.3	12.7	11.5	10.42	9.5	8.8	8.2	7.7	7.15
46	1204	1505	1806	2112	2408	2709	3010	3311	3612	3913	4215	4516	4817
	27.4	22	18.3	15.6	13.7	12.2	11	10	9.1	8.4	7.8	7.3	6.85
48	1257	1571	1885	2199	2513	2827	3142	3456	3770	4084	4398	4712	5026
	26.3	21	17.5	15	13	11.7	10.5	9.5	8.75	8.10	7.5	7	6.57
54	1414	1767	2120	2474	2827	3180	3534	3887	4241	4594	4948	5291	5655
	23.3	18.7	15.5	13.3	11.7	10.4	9.33	8.5	7.8	7.2	6.67	6.25	5.85

Width of Belt = 1 inch for each 50 pounds motive force.

Table III on page 639 gives the surface speed of shafts,—that is, the number of feet per minute through which the load on the journals has to move. Table IV gives the approximate weight of pulleys. These tables can be used for other calculations of a similar character, and I may say, in passing, that such calculations have an advantage entirely apart from the economy that may be effected in any particular case, in that they give a clear idea of what is advantageous and what is not. The person who has once mastered the intricacies of such calculations as follow (and they are not difficult) can readily make changes which he will know, without calculation, to be economical, though he may not know the extent of the saving.

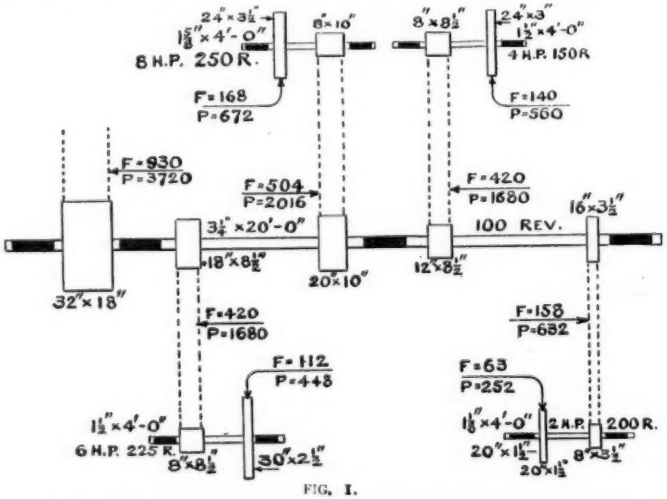


FIG. I.

The conditions assumed are that four machines, requiring 2, 4, 6, and 8 h.p. respectively, are located on a floor by themselves. Required, a main line of shafting 20 feet long, and belting to counters for these machines. What arrangement and sizes are best, and what horse power must be delivered to the main line?

It is probable that the arrangement shown in Fig. 1 would, in a majority of cases, be considered satisfactory. Certain figures are added for facilitating the calculations, in which F = the motive force required to transmit the given h. p. at the speeds used, and P = the pressure on the journals due to the pull of the belts, which is taken as 4 F. In the calculations which follow no account is taken of any losses except those which occur at the journals, the assumption being

TABLE III.

Diameter of Shaft.	Surface Speed of Shafts. Revolutions per Minute.												
	100	125	150	175	200	225	250	275	300	325	350	375	400
½	13.1	16.3	19.65	22.9	26.1	29.4	32.7	36	39.3	42.6	45.8	49.1	52.3
⅝	16.35	20.5	24.65	28.6	32.7	36.8	41	45	49.1	53.1	57.2	61.3	65.4
¾	19.65	24.6	29.4	34.35	39.3	44.15	49.1	54	58.9	63.8	68.7	73.6	78.5
⅞	22.9	28.7	34.3	40	45.8	51.5	57.3	63	68.7	74.4	80.1	85.9	91.6
1	26.1	32.8	39.3	45.8	52.3	58.9	65.4	72	78.5	85.1	91.6	98.2	104.7
1⅛	29.5	36.9	44.1	51.6	58.9	66.2	73.6	81	88.3	95.7	103.1	110.5	117.8
1¼	32.7	41	49.1	57.2	65.4	73.6	81.8	90	98.1	106.3	114.5	122.7	130.9
1⅜	36	45	54	63	72	81	90	99	108	117	126	135	144
1½	39.3	49.1	58.9	68.7	78.5	88.3	98.2	108	117.8	127.6	137.5	147.2	157.1
1⅝	42.5	53.2	63.8	74.4	85	95.7	106.3	116.9	127.6	138.2	148.8	159.4	170.1
1¾	45.8	57.3	68.2	80.1	91.6	103	114.5	126	137.4	148.8	160.3	171.7	183.2
1⅞	49.1	61.3	73.6	85.9	98.1	110.4	122.7	135	147.2	159.5	171.8	184	196.3
2	52.3	65.4	78.5	91.6	104.7	117.8	130.9	144	157.1	170.2	183.3	196.3	209.4
2⅛	55.6	69.5	83.4	97.3	111.2	125.1	139.1	153	166.9	180.8	194.7	208.5	222 5
2¼	58.9	73.6	88.3	103.1	117.8	132.4	147.3	162	176.7	191.4	206.2	220.7	235.6
2⅜	62.1	77.7	93.2	108.8	124.3	139.8	155.4	171	186.5	202	217.6	233	248.7
2½	65.4	81.8	98.1	114.5	130.9	147.2	163.6	179.9	196.3	212.7	229	245.3	261.8
2⅝	68.7	85.9	103	120.2	137.4	154.6	171.8	189	206.1	223.3	240.5	257.6	274.9
2¾	72	90	108	126	144	162	180	198	216	234	252	270	288
2⅞	75.2	94.1	112.9	131.7	150.5	169.4	188.2	207	225.8	244.6	263.5	282.3	301.1
3	78.5	98.2	117.8	137.5	157.1	176.7	196.3	215.9	235.6	255.2	274.9	294.5	314.2
3¼	85	106.3	127.6	148.8	170.1	191.3	212.6	233.9	255.1	276.4	297.7	318.9	340.3

TABLE IV.

Diameter.	Approximate Weight of Pulleys. Face in Inches.												
	2	3	4	5	6	7	8	9	10	11	12	14	16
8	11	13	15	17	19	21	23	25	27	29	31	35	40
10	13	15	17	20	23	25	28	31	33	36	38	44	49
12	15	17	20	24	27	30	33	37	40	43	46	52	59
14	17	19	22	27	30	35	38	42	46	50	54	61	68
16	18	21	25	30	34	39	43	48	52	57	61	70	78
18	21	24	29	34	39	44	48	53	58	63	66	75	84
20	23	28	33	38	43	48	53	58	63	68	73	83	92
22	27	32	37	42	48	53	58	63	68	73	78	88	98
24	30	35	40	46	51	56	62	68	72	78	83	94	105
26	33	38	44	50	56	62	67	72	78	83	89	100	111
28	36	42	48	54	60	66	72	78	84	90	95	106	118
30	39	45	52	58	64	70	77	83	89	95	101	113	125
32	41	48	55	62	68	75	82	88	94	100	107	120	133
34	45	52	59	66	73	80	87	93	100	106	112	126	139
36	48	55	63	71	78	85	92	98	105	111	118	132	145
38	51	58	66	74	82	90	97	103	110	117	124	138	152
40	54	62	70	78	86	94	102	109	116	123	130	145	159
42	58	66	74	82	90	98	106	114	121	128	136	151	166
44	61	69	77	85	93	102	111	119	127	135	142	158	172
46	63	72	81	90	99	108	116	124	132	140	148	164	179
48	67	76	85	94	103	112	121	129	137	145	154	170	186
54	76	86	96	106	116	126	136	146	156	166	176	196	206

that other things remain the same. As a matter of fact, some of the changes made—for example, the use of larger pulleys—bring about incidental economies, which will be readily understood from what has been previously said.

As shown in Fig. 1, the calculation for the 2-h. p. counter is as follows:

Weight of 1⅛″ shaft	14
Weight of 20″ × 1½″ pulley	20
Weight of 8″ × 3½″ pulley	14
P. on 20″ pulley	252
P. on 8″ pulley	632
Load on journals	932

Multiplying this by 58.9, the speed at which a 1⅛″ shaft moves at 200 revolutions per minute, we have

$$932 \times 58.9 = 54{,}895\ k,$$

in which k = coefficient of friction of shafting—usually about .075.

Treating the other counters and the main line in the same way, we find the figures for k shown in column A of the annexed table. Adding these up, and reducing to horse power as follows, we have:

$$\frac{1{,}584{,}615 \times .075}{33{,}000} = 3.602$$

as the amount of h. p. lost by friction in transmitting 20 h. p. through the main line and counters to the machines, or a total of 23.6 h. p. that must be delivered to the main driving pulley.

By inspection of Fig. 1, it will be seen that, by turning the 2-h. p. and the 4-h. p. counters end for end, without changing the location of the machines, the 12″ and 16″ pulleys on the main line may be brought close together. As the pull, P, on each of these is in opposite directions, they would then neutralize each other, and the pressure on the journals of the main line would be the difference between 1,680 and 632, instead of their sum. By making this change and doing the same for the other counters, we have the arrangement shown in Fig. 2, the calculations for which are given in column B. It will be seen that this very simple change saves nearly 25 per cent. of the friction loss, as originally planned.

If the speed of the main line be raised to 200 revolutions per minute, and the pulleys be reduced in diameter so as to maintain the same belt-speed, the diameter of the shaft could be reduced to 2½ inches and the pulleys would be lighter. This would reduce the total load on the journals of the main line from 5,821 to 5,457 pounds, but would increase the friction speed from 85 to 130.9 feet per minute, and the calculation would be

$$5{,}821 \times 85 = 511{,}785\ k \text{ and}$$
$$5{,}457 \times 130.9 = 714{,}300\ k,$$

or a distinct and large loss. It is, therefore, unprofitable to make changes of that kind.

If the main line makes 200 revolutions, with the pulley-diameters maintained, the belt-speeds will be increased, and the pulley-faces may be less. Another result will be larger and narrower pulleys on the counters. The effect of this change is to reduce the load on each shaft, and to increase the friction-speed only on the main line. The result is shown in column C, in the table below, in which it will be seen that there is a saving at every point, the whole being 31 per cent. better than B and 48 per cent. better than A.

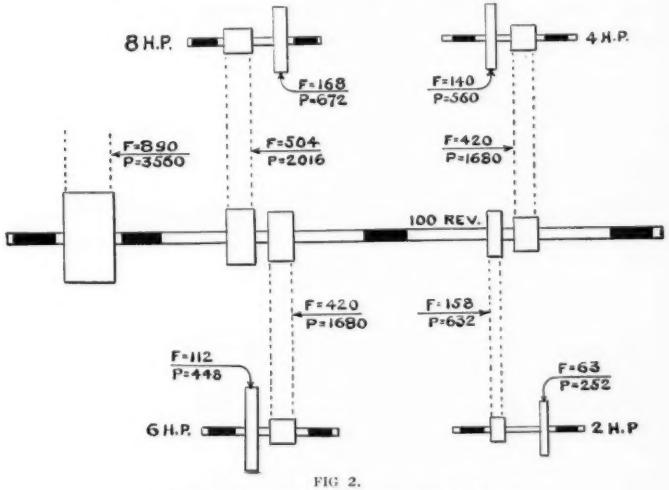


FIG 2.

TABLE SHOWING EFFECT OF CHANGES:

SHAFT.	A	B	C	D	E	F
2 H.P.	54895	54895	36518	36518	28155	23256
4 H. P.	136825	136825	87526	87526	63612	56662
6 H.P.	195850	195850	121942	121942	86090	70518
8 H. P.	295620	295620	188787	188787	136700	113584
Main	901425	508385	384581	285770	243605	199100
Total	1584615	1191575	819354	720543	558162	463120
H. P	3.602	2.708	1.862	1.638	1.268	1.052
Saving by change	....	24.8%	31.24%	12.08%	22.59%	17.03%
Total saving from A.	....	24.8%	48.31%	54.52%	63.33%	70.8%

If, instead of increasing the revolutions, the main line remain at 100 and the diameters of the pulleys be increased to obtain the same belt-speed as in the last instance, the only difference will be in the main line, where the load will be increased and the friction-speed decreased. The calculations for this condition are shown in column D, from which it will be seen that obtaining the high speed of belts by enlarging the pulleys is 12 per cent. better than obtaining it from increased revolutions.

If we use the pulley-diameters of case D and the revolutions of case C, we again increase the belt-speeds, and make a saving in each item, as shown in column E. That these successive changes may not be lost sight of the arrangement is shown in Fig. 3. By comparing

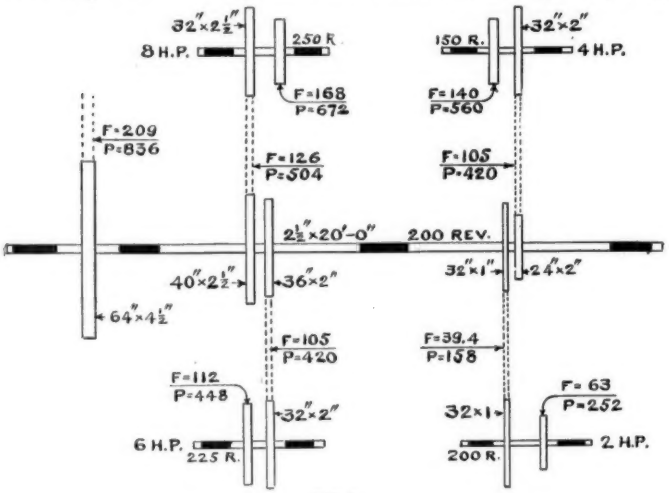


FIG 3.

Figs. 2 and 3, and the calculations for them as shown in columns B and E, we see that, by doubling the revolutions and doubling the pulley-diameters, thereby obtaining four times the belt-speed, we have saved more than half of the power previously wasted by friction.

Again resorting to inspection, we see in Fig. 3 that for the 2-h. p. counter P = 158, and for the 4-h. p. P = 420. This leaves an unbalanced load of 262 pounds on the main line. If we reduce the pulleys for 2-h. p. from 32 inches to 12, we increase P for this to 420. This balances the pull on the main line by transferring the 262 pounds to the 2-h. p. countershaft. As the main shaft is 2½ inches in diameter and the countershaft only 1⅛ inches, this load does not move so

rapidly; consequently there is a saving of $(130.9-58.9)\times 262=18{,}864\ k$. There is also a slight saving by decrease in weight of pulleys. This illustrates the fact that it is sometimes economical to decrease belt-speeds, instead of increasing them.

If, after having obtained the balance on the main line, we again increase belt-speeds by replacing the 24-inch and 12-inch pulleys by 36-inch and 18-inch pulleys respectively, putting suitable pulleys on the counters, we do not disturb the balance, while we reduce the pull on each counter from 420 to 280 pounds, less the increased weight of pulleys. This gives an additional saving of nearly 18,000 k. Under the conditions last assumed, the 2-h. p. countershaft is $1\frac{1}{8}$ inches in diameter, runs 200 revolutions per minute, and carries 18-inch and 20-inch pulleys. If these pulleys be increased to 36 and 40 inches, and the shaft to $1\frac{3}{8}$ inches, the belt-speeds to the main line and to the machine will be maintained, and the load on the journals only slightly increased, while the friction-speed will be reduced from 58.9 to 36 feet per minute as a consequence of reducing the revolutions from 200 to 100. Following the same process for the 6-h. p. and 8-h. p. countershafts, reducing their speeds respectively to 150 and 200 revolutions per minute, and aggregating the whole, we have the results shown in column F, from which it is seen that we have obtained a saving of 70.8 per cent. of the power required by the arrangement shown in Fig. 1.

The series of changes that have been explained in detail show that the original arrangement was extravagantly wasteful; yet it is a fair representation of what may be seen in many places. In the first instance, the loss of power was about 16 per cent. of that delivered to the main line, which loss is reduced by the changes to about 5 per cent. in the last case. Ordinarily 20 h. p. would be carried through much longer lines and be divided into much smaller units. In such cases the percentage of loss would be greater, and the saving by improved arrangement correspondingly large. Instances are on record of losses ranging from 30 to 40 per cent., and even more, of the total. In such cases part of the loss is probably due to bearings being out of line or shafts bending under the loads they carry, and to incidental causes purposely omitted from the calculations presented.

THE CYANID PROCESS FOR GOLD ORES IN WESTERN AMERICA.

By Thomas Tonge.

THE annually-expanding output of gold in America is attracting more and more attention, and resulting in the investment of an ever-increasing amount of capital in gold-mining and gold-ore-treatment enterprises. Much of the recent gold production is owing to the improved methods of extracting the gold from the low-grade and refractory ores which in former years were left either in the mine, or on the dump, or in the stamp-mill tailings, because there was then no known method for the economical and profitable recovery or saving of the gold values in such ores.

The revolution since effected is largely owing to the discovery and subsequent development of the cyanid process. While it had been known for many years that potassium cyanid was a solvent of gold, it had been used only in a very limited way,—in the laboratory or in the treatment of the plates of amalgamation batteries,—and it was not then known by practical men that a weak solution of cyanid would dissolve crude and complex ores direct.

In 1867 a United States patent was issued to Julio Rae for the treatment of argentiferous ores by potassium cyanid and electricity in combination. In July, 1885, a United States patent was issued to Jerome W. Simpson for the treatment of ores by a combination of potassium cyanid and ammonium carbonate. But neither of the foregoing processes was capable of successful operation commercially, owing to the fact that there was then no known method of recovering the precious-metal values from the solutions.

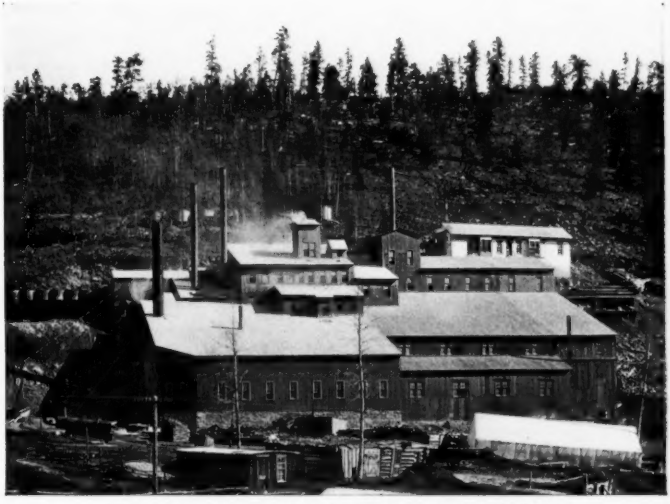
In October, 1887, letters patent were issued in Great Britain to John S. McArthur, Robert W. Forrest, and William Forrest, covering what is now commonly known as the McArthur-Forrest cyanid process, which treats crushed ore, either by agitation or percolation, —preferably percolation,—with a very diluted solution of potassium cyanid, the gold being precipitated upon zinc shavings, or by the Siemens-Halske process, or precipitation by electricity, on sheet lead, the slimes of zinc and gold, or the amalgam of lead and gold, being subsequently refined in the ordinary way and the pure gold extracted.

The United States patent for the McArthur-Forrest process was obtained in May, 1889, and in May, 1890, the first company in the United States—*viz.*, The Gold and Silver Extraction Mining and Mill-

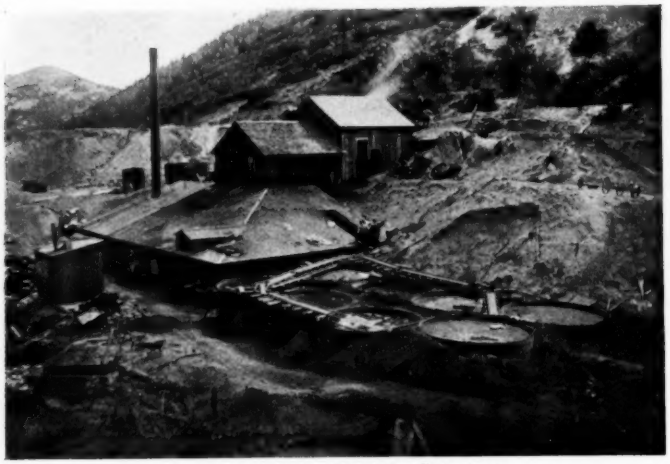
WORKS OF THE METALLIC EXTRACTION CO., CYANIDE, COLORADO.

ing Co.—was organized in Denver, Colorado, to operate the process in America. The company at once established in a suburb of Denver a demonstration plant sufficiently large to handle carload lots. Among the first large samples was one from what is now known as Mercur, Utah, in a district which has since become famous as a gold producer, entirely owing to the adoption of the cyanid process and its improvements from time to time.

As showing the incredulity with which the process was at first received, it may be mentioned that the first carload of Mercur ore was taken seven hundred miles to the demonstration plant at Denver, by



THE BRODIE REDUCTION MILL, CRIPPLE CREEK, COLORADO.



SPANISH GOLD MILL, BINGHAM CAÑON, UTAH.

Mr. Gill S. Peyton, who was the assayer and one of the owners of the Mercur Mine (for which property a considerable sum had been paid, only to find that no then known process would profitably take out the gold values). Mr. Peyton's partners were so incredulous as to the new process that they not only discountenanced the shipment, but declined to defray any of the expense. He, however, took out the ore and loaded it on a car; but, not having sufficient money to pay the freight, he went on to Denver, where he induced the manager of the Cyanid Company to advance the necessary sum, on condition that Mr. Peyton would put on his overalls, go into the mill, and personally witness and check off the work of the company's chemist in charge of the operations, so that he would be thoroughly satisfied as to the efficiency of the process. The car of ore duly arrived, and the merits of the process were clearly demonstrated, with Mr. Peyton as an eye-witness. He returned to Utah, raised the necessary money, and put up a small plant with a capacity of ten tons per day. Since that time the Mercur district has produced millions of dollars in gold, and the present aggregate daily capacity of the local cyanid plants is nearly five hundred tons.

About the time that Mr. Peyton was investigating, Mr. Almarin B. Paul, of San Francisco, one of the leading metallurgists in California, visited Denver to investigate the new process, and, if found satisfactory, to arrange for its introduction into California. As a result he organized the Shasta Gold Extraction Company, and erected a plant

at Metal Creek, Shasta county, California, which was operated successfully, with a high percentage of extraction, so long as the local ores lasted. He also arranged with another company in the same county for a plant, which has been in successful operation for several years.

About that time also a license to use the process was granted to the Livingstone Gold Mining Company in the Sugar Loaf district, Boulder county, Colorado, which mill was operated successfully for severa years—as long as the ore was taken from the mine.

In the fall of 1892 Mr. R. B. Turner visited Denver with a carload of ore from the Revenue mine, Madison county, Montana. So high a percentage of the values in this carload of ore was saved at the Denver experimental plant that Mr. Turner returned to Montana and erected a plant; it was only partially successful, as stamps and wet crushing were used, causing the ores to slime so badly as to prevent good filtration. A second mill was then erected, where rolls and dry crushing avoided the making of slimes; this proved successful.

During the above period there were other plants started. In November, 1893, the Gold and Silver Extraction Mining and Milling Co. sold out the Colorado incorporation to The Gold and Silver Extraction Company of America, Limited. The latter company, organized under the laws of Great Britain and with American headquarters in Denver, now has the ownership or control in America of the original McArthur-Forrest cyanid process.

In September, 1894, The American Cyanid Gold and Silver Re-

INTERIOR OF 60-TON TANK, METALLIC EXTRACTION CO., CYANIDE, COLORADO.
Moffat-Smith McArthur-Forrest Process.

PRIMITIVE CYANID PLANT ON CLEAR CREEK, NEAR DENVER, COLORADO.

CYANID PLANT OF NIAGARA CO., BINGHAM CAÑON, UTAH.

covery Company came into existence, also with headquarters in Denver, Colorado. This company is based on the Kendal process, covering a combination of sodium dioxid and potassium cyanid. The company holds several United States patents covering processes for the recovery of the precious metals from solutions.

In the meantime a third company came into existence, under United States patents issued in 1894, 1895, and 1896, also with American headquarters in Denver,—*viz.*, The General Gold Extracting Company, Limited, based on the Pelatan-Clerici process, which is a treatment of the crushed ore by agitation in a diluted solution of potassium cyanid, with an electrical current and direct precipitation upon mercury.

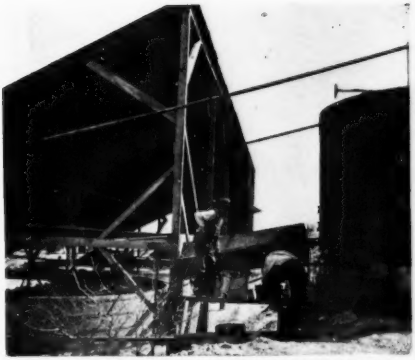
PRECIPITATING BOXES, WISWALL-FRANK PROCESS.

It is no part of this article to deal with the rival claims or alleged advantages of these three competing enterprises, but rather to deal with the cyanid process generally, apart from the controversial phases, and its importance as a factor in the increasing production of gold from ores which could not previously be mined and treated at a profit. Those mine-owners and capitalists who are disposed to utilize the process can decide for themselves, after full investigation, which process they will adopt.

The following incomplete list of the cyanid plants in operation in the gold-producing States and territories shows the wide extent to which the process, in one or other form, has been adopted :

Plant.	Material Treated.	Tons per Day.
Arizona.		
Congress Mill (Yavapai county).....	tailings	100
Haquahala Mill (Yuma county,).....	"	100
Fortuna Mill (Yavapai county).....	"	75
Helm Mill, Wickenburg (Maricopa county).....	"	50
McLeish Mill (Maricopa county).....	"	50
Tombstone (Cochise county).....	"	10
California.		
Bodie Mill, Bodie (Mono county).....	"	150
Standard Mill " " "	"	150
Young America Mill, Sierra Nevada Mts.	"	50
Parr & Tyack Mill, Bodie.....	"	25
Hunt & Holbrook Mill (Amador county)	"	25
Black Oak Mine Mill.....	"	15
Maydwell Hart Mill (San Bernardino county).....	"	10
Dunderberg Gold Mines, Ltd.....	"	10
Stent Cyanid Co.....	"	10
Colorado.		
Metallic Extraction Co., Cyanid.....	crude ore	400
Brodie Mill, Cripple Creek.....	" "	100
American Reduction Mill, Florence.....	" "	75
St. Elmo Mill (Chaffee county).....	tailings	75
Arequa Gulch Mill, Cripple Creek.....	crude ore	50
Holy Cross Mill (Eagle county).....	" "	50
Leadville G. & S. Extr. Co. (Lake county)	" "	50
Idaho.		
Delamar Mill (Owyhee county).....	crude ore	50
Idaho Recovery Co. Mill.....	" "	50
Montana.		
Revenue Mill, Revenue.....	crude ore	60
Harsh Mill (Lewis county).....	" "	50
Mueller Mill (Madison county).....	" "	25
Nevada.		
Delamar Mill, Delamar.....	crude ore	300
Eureka Mill, Eureka.....	tailings	100
Willis Mill, Battle Mountain.....	"	60
Pierson, Carson River.....	"	50
North Mountain Mill, White Pine	crude ore	50
Union Mill, Tuscarora.....	concentrates	50

ERECTING A SMALL CYANID PLANT.



LEACHING TANK, ZINC BOX, AND SUMP TANK.

A PRIMITIVE ARIZONA PLANT.

ANOTHER SMALL CYANID PLANT IN ARIZONA.

FORTUNA TAILING PLANT, ARIZONA.

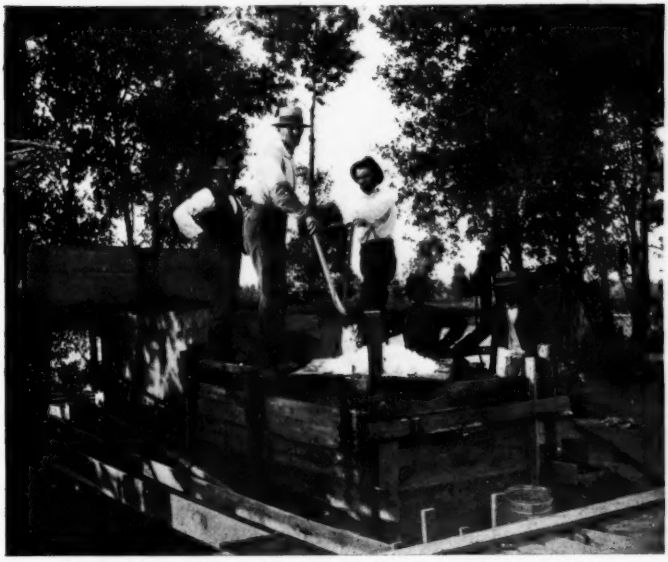
NORTH MOUNTAIN MILL, CHERRY CREEK, NEVADA.

New Mexico.		
Homestake Mill, White Oaks.....	tailings	40
South Dakota.		
Black Hills Extraction Co., Black Hills..	crude ore	50
Golden Reward Mill, Black Hills.....	" "	40
Utah.		
Mercur Mill, Mercur	crude ore	400
Northern Light Mill (Tooele county) ...	" "	200
Marion-Geyser Mill, Mercur.....	" "	75
Sacramento Mill	" "	50
Bingham Mill, Bingham.....	" "	35

SUMMARY.

State or Territory.	Mills.	Tons per Day.
Arizona.....	6	385
California	9	445
Colorado.....	7	800
Idaho.....	2	100
Montana	3	135
Nevada	6	610
New Mexico	1	40
South Dakota	2	90
Utah	5	760
Total.....	41	3,365

ROASTING CYANID PLANT, CONGRESS GOLD CO., CONGRESS, ARIZONA.



PRIMITIVE CYANID PLANT ON CLEAR CREEK, NEAR DENVER, COLORADO.

The following brief description by the superintendent of the cyanid plant at Congress, Arizona, treating tailings, gives a fair idea of the others:

The plant is running on tailings from our forty-stamp concentrating mill. There is a very large accumulation of tailings, and more are being made all the time at about the rate that they are used. The tailings are dried, put through a Stedman pulverizer, and elevated to the storage-bin shown on the left of the photograph. From this bin they are fed automatically to a Brown roasting furnace, where they are thoroughly desulphurized and oxidized. Emerging from the roaster, they pass over a cooling floor, and discharge into a bin which feeds the elevator used in charging the tanks. Hand labor is thus almost entirely dispensed with from the time the tailings enter the pulverizer until the leaching process is completed and the tailings, exhausted of their gold contents, are ready to go on the dump as final waste. The discharging is done by hand, as the water-supply is not sufficient to permit of sluicing.

The leaching tanks are 26 feet in diameter by 4½ feet deep. Zinc precipitation is used, and the bullion produced is between 800 and 900 fine. The zinc house is on the extreme left. Crude oil is used for fuel in the roasting-furnace, and coal under the boiler. A spur from our railroad runs into the works for bringing in supplies.

In addition to the mills mentioned in the foregoing list, there are various smaller plants. An illustration is given of one of these somewhat primitive enterprises on Clear Creek, a few miles from Denver, treating material taken from the banks or bed of the stream, which drains

the auriferous districts of Gilpin and Clear Creek counties, lying about forty miles up stream from the plant in question.

It is now seven years since the cyanid process was introduced into America, South Africa, and New Zealand. In each country a rapid increase in the output of gold bullion has taken place as a consequence. A wonderful stimulus has been given to gold mining, while abandoned mines and tailing dumps have been the scenes of renewed activity, and have been made to pay handsomely.

Gold ores may be broadly divided into two classes:

(1) Those that yield up their gold entirely, or nearly so, to treatment with mercury and various other methods; (2) those of too low grade for smelting, and from which the gold cannot be extracted in any other way, or only in so partial a manner as to give no profitable results.

The former are known as "free gold" or "free milling" ores, and the latter are variously termed "refractory" or "rebellious" ores, for the reason that they cannot be worked profitably by ordinary amalgamation.

In the "refractory" ores ingredients are invariably found which act upon the mercury, or the chemicals with which extraction has hitherto been attempted, to the extent of preventing effect upon the gold and silver which it is sought to recover. Many of these ores are especially amenable to the cyanid process.

For every ton of "free gold" ore, or "free milling" ore, there are hundreds of tons of ore, too low in grade to pay for the necessary hauling, railroad freight, and smelting, and so refractory that

IDAHO RECOVERY COMPANY'S PLANT.

they have hitherto been either left in the mine or thrown as valueless on the waste dump, although frequently showing richer assay values than the free milling ores actually treated.

PRIMITIVE HOISTING WHIM.

In the vast region lying between the British line and the borders of Mexico, and from Denver westward to the Pacific, there are millions of acres of mineral lands, containing thousands of strong veins of refractory ores, which await only a proper process of gold extraction to render them highly profitable. In many such cases the cyanid process presents the solution of this great commercial problem, and every year sees this solution nearer. Moreover, the cyanid process is particularly applicable to ores containing gold in those minute particles which, in the stamp and amalgamating process, are largely lost in the slimes.

There are about forty cyanid plants operating on the different mines in the Witwatersrand district of South Africa, where, however, the question is infinitely simplified by the fact that they deal with a uniform ore, this ore being treated by amalgamation, to save as much gold as possible on the plates, and the tailings being then subjected to the cyanid process. Yet only about seventy per cent. of the gold value in the tailings is recovered.

In America, on the contrary, the question was and is much more difficult and complicated, as an infinite variety of crude, refractory ores are successfully treated and from eighty to ninety-five per cent. of the gold values saved. In America the cyanid process treats at a profit tailings averaging as low as three dollars per ton, the total cost of handling, chemicals, etc., being about fifty cents per ton and the net profit two dollars and fifty cents per ton. At one place crude ore averaging as low as five dollars and fifty cents in gold and three ounces of silver per ton is mined, hauled, crushed, and treated by the cyanid process at a comparatively handsome profit.

The cyanid process, however, is not exempt from the undeserved failures arising from ignorance, incompetence, and careless inattention to necessary details and even to fundamental principles. Men who have not thoroughly mastered its theory and practice build plants

which do not admit of the most economical and efficient gold extraction, and in the operation of these plants the maximum of chemicals is sometimes used and the minimum of gold extraction effected, to the great injury of the owners of both mines and plants, who frequently are oblivious to wasteful methods and consequent money losses.

The following unassailable principles must be recognized:

(1) That no cyanid plant should be erected until the ores proposed to be treated have been thoroughly tested by a cyanid expert of undoubted ability and integrity, and pronounced entirely suitable for the process, or for some modification thereof adapted to that particular class of ore.

(2) That no cyanid plant should be erected, except on the plans and under the supervision of a man who has made a special study of the process.

(3) That such a plant, when completed, should be placed under a manager who has had a thorough technical and practical training in the process.

Failures following any ignoring of these precautions cannot justly be charged to the process.

REVIEW OF THE ENGINEERING PRESS

CONTENTS.

ARCHITECTURE AND BUILDING.
Architectural Distortion 666
Cantilever Foundations 670
The Proper Study of Architecture..... 675

CIVIL ENGINEERING.
The American Society of Civil Engineers 665
Deep Waterways to the Atlantic.....667
Hydraulic Dredging..... 669
The Measurement of Wind Pressure.... 679
The New Faidherbe Bridge 684
Photographic Altitude Measurements 686

ECONOMICS AND INDUSTRY.
The Engineers' Strike 673
Diagram Accounts.....676
The Cost of Power.....687

ELECTRICAL ENGINEERING.
Electro-Chemical Progress.....675
Electrical Transmission in Workshops ...682

MARINE ENGINEERING.
United States Gunboat Trials.....670

MECHANICAL ENGINEERING.
The Calorific Value of Coals.....666
Rope Driving..... ... 668
Mathematics for Engineers.....671
The Purification of Feed Water 672
Compression in Steam Cylinders 681
A New Method of Testing Materials 682
The Strength of Cylinder Heads.....683

MINING AND METALLURGY.
Metallography as a Method of Research..685
Mixtures of Iron and Steel 685

MUNICIPAL ENGINEERING.
Acetylene Mixtures..... 674
Fire Protection in London.. ... .680
Sewage Purification at Spandau... 686

RAILWAY AFFAIRS.
High-Speed Locomotives 677
The Caillet Monorail.....683

STREET AND ELECTRIC TRAMWAYS.
Electrical Traction 678

The American Society of Civil Engineers.

WE have already chronicled in these columns the completion of new homes for the French, German, and British engineering societies, and the American Society of Civil Engineers is not far behind, the new building for this, the oldest of the engineering societies of the United States, having been publicly opened on November 24, 1897.

This event is duly recorded in most of the engineering journals, but we must remark especially the fine view of the building in the *Iron Age* of November 25.

The American Society of Civil Engineers dates from 1852, and has numbered among its members some of the most distinguished engineers in the United States, as well as many able men of foreign countries. Originally the society occupied rooms at William and Cedar streets, New York, subsequently shifting as the membership increased, until in 1881 the quarters in Twenty-third street were purchased. The new building, situated at No. 220 West Fifty-seventh street, is a handsome structure of the French renaissance school, from designs by Mr. C. L. W. Eidlitz, and has been carefully planned to meet the requirements of the society. In addition to business offices and a conversation room on the first floor, there is on the second floor a fine auditorium, seating more than four hundred persons, and also a convenient reading-room. The books are stacked on the fourth floor, where there is a capacity for one hundred thousand volumes, and an electric book-lift serves to convey the volumes to and from the reading-room. The third floor is devoted to the model-room and museum, so that the entire building is appropriated to engineering purposes.

The cost of the structure was $200,000, including the ground, the assets of the society being about $250,000, and its income about $40,000 per annum, the membership being over twenty-five hundred.

The Calorific Value of Coals.

WITH the increasing practice of rating boilers by a comparison of the heat units in the steam with the calorific value of the coal there has come a renewed interest, not only in the heating power of coals from various sections, but also in the methods for determining that heating power.

This question forms an important portion of the preliminary draft of the report of the committee of the American Society of Mechanical Engineers, submitted at the December meeting at New York and incorporated in the *Transactions;* and is also the subject of a paper presented before the American Institute of Mining Engineers by Mr. William Kent at its Lake Superior meeting.

The report of the boiler-test committee is emphatically favorable to the use of the Mahler calorimeter, and recommends that method whenever practicable; and, as the apparatus is now available in many laboratories, samples of the coal used in a boiler test may be reserved, and the calorific value subsequently determined.

When the calorimeter is not at hand, recourse must be had to chemical analysis, generally using the formula of Dulong, and substituting the values for carbon, oxygen, and hydrogen from the analysis.

Mr. Kent's paper is a discussion of the valuable experimental tests of Messrs. Lord and Haas, presented at a previous meeting of the American Institute of Mining Engineers, and shows in a very interesting manner how fully these tests of American coals fall into the general range of coals of various composition, as classified by calorific value. In their original memoir Messrs. Lord and Haas thought that no general law could be found to govern the calorific power of coals, but Mr. Kent has plotted the curve for Mahler's tests, using as ordinates the number of calories per pound of coals and as abscissas the percentage of fixed carbon, and shows very clearly that the tests of Mahler, Lord, Haas, and Houghton agree much better than had been supposed possible.

The question as to the propriety of including a factor for the heat of the sulphur in the coal is one about which there has been some discussion, and in a note to the report of the boiler-test committee Mr. Kent objects to the use of such a factor, on the ground that the sulphur does not exist in the free state, but as sulphide of iron, etc., and has little or no value as fuel. Professor Lord has shown, however, that there is a very definite heat-value attributed to the combustion of the pyrites to sulphuric acid, and in Germany Baron Jüptner von Jonsdorff, who has also made an elaborate analysis of the tests of Messrs. Lord and Haas, distinctly includes the calorific value of the sulphide of iron as burned to SO_3.

The Society of German Engineers, and the International Society for Boiler Inspection, have united upon a modification of the Dulong formula, which is known as the *Verbands-Formel*, and which includes terms for sulphur, and for moisture, together with slightly modified values for the constant coefficients; and, unless there is some very good reason for doing otherwise, it is to be hoped that the boiler-test committee of the American Society of Mechanical Engineers will further the cause of international unity of methods by adopting this formula.

Architectural Distortion.

IT is a well-ascertained fact that in certain mediæval cathedrals there is a marked deviation from what would ordinarily be called correct workmanship. Walls and columns are not plumb; pillars and arches in the same colonnade are not similar in dimensions or proportions; and other apparent vagaries are found. Some have attributed these facts to ignorance or carelessness; others to the unequal settling of foundations, or the yielding of piers to the thrusts and stresses which have been thrown upon them; while some have distinctly affirmed these deviations from geometrical rectitude to be intentional and premeditated, and to form part of a system of pseudo-perspective intended to produce certain optical effects upon the spectator.

Professor William H. Goodyear has an interesting discussion of this subject in the *Architectural Review* (Dec., 1897), and

his investigations of certain structures have been made with so much care that they offer excellent material for study.

That this artificial distortion was known, or at least suspected, more than two hundred years ago—that is, after the decline of mediæval architecture and before the development of modern methods—is shown by the quotation from Evelyn's diary in 1665 referring to the inspection of the tower of Old Saint Paul's by Wren, Evelyn, Chichley, Prat, and others, in which Evelyn says: "Finding the main building to recede outwards, it was the opinion of Mr. Chichley and Mr. Prat that it had been built *ab origine* for an effect in perspective, in regard of the height; but I was, with Dr. Wren, quite of another judgment, and so we entered it."

Old Saint Paul's is no longer with us for examination, but it is very likely that Chichley and Prat were right, and Professor Goodyear has given us measurements and photographs of existing buildings, notably of St. Mark's at Venice, showing that such a distortion does exist, and apparently is the result of intention.

The photographs used by Professor Goodyear were taken by Mr. McKecknie, of the Brooklyn Institute, who used every care to avoid photographic distortion. The camera was carefully plumbed and levelled, and, when tilting was found necessary, the swing-back was kept accurately vertical.

Photographs and measurements both show that the main piers supporting the dome of St. Mark's have a spread of nearly three feet in the rise from the floor to the springing of the arch; like St. Paul's, the main building "recedes outwards," and this, too, with no evidence either of settling or of yielding to thrust. A similar spread is visible in the transepts to about one-half the extent, and this deviation from the vertical is so evidently intentional as to reveal itself as a portion of the original design.

This spreading is exactly in the direction to counteract the optical tendency to convergence, and so carefully has it been done that, to the eye of an observer on the floor of the cathedral, the piers appear vertical. Observed from the gallery, where the perspective effect is lacking to correct for the spread, the distortion is apparent, but even from there it has been but little noticed. Similar effects are found in the Cathedral of Triani, in the Church of SS. Giovanni e Paolo, Bologna, and in the Church of S. Maria al Arezzo; and in all these cases a careful inspection of the masonry showed no cracking or settlement distortion. In the case of the façade of S. Ambrogio at Milan the spread is clearly shown to extend to the upper central arch in a manner which could hardly have been accidental under any circumstances, and in numerous other cases a similar state of affairs is shown to exist.

Professor Goodyear disclaims for the present any positive deductions from the facts he has so carefully observed, preferring "to consult the opinion of optical and artistic experts after the facts have been brought to light," but it is evident that he himself is convinced, as indeed most of his readers will be, that the mediæval cathedral builders knew what they were about, and labored intelligently with more or less success to introduce artificial perspective effects.

Deep Waterways to the Atlantic.

FOR some time the advisability of considering seriously the construction of a ship canal from the Great Lakes to the Atlantic has been discussed in various quarters, and an organization called the Deep Waterways Association has done effective work in improving the lake harbors and in agitating the question of the ship canal.

In order that the subject might be considered intelligently, the secretary of war appointed Major Thos. W. Symons, Corps of Engineers, U. S. A., to make an examination of the project. Major Symons's report has been made public, and a very full abstract, together with an editorial discussion and some interesting correspondence, is given in *Engineering News* (Nov. 11). Major Symons admits that he entered upon this task with a prejudice in favor of a ship canal, and hence the fact

that his report is distinctly adverse to the project can hardly be charged to personal prejudice. He has, however, been careful to investigate the subject, not only from an engineering standpoint, but also from a commercial position, and his report certainly appears to be that of a disinterested expert.

Of course, the primary object of a ship canal to the Great Lakes would be to permit sea-going steamers to proceed directly to Chicago or Duluth, and there receive their cargoes, but this would be done only if there was a distinct commercial advantage in so doing. As a matter of fact, the exigencies of lake transportation have so developed the systems of handling and shipping there that much of the cost and delay of reshipping has been avoided, and a special division of shipping has been evolved, admirably adapted for lake traffic, but quite unsuited for ocean service. Under these circumstances Major Symons is compelled to report that he is of opinion that a canal capable of bringing the cargoes of the lake traffic to the seaboard in barges of less than 16 feet draft, there to be reloaded into the ocean steamers, is to be recommended rather than a ship canal for vessels of, say, 28 feet draft.

The cost of a 28 foot ship canal is estimated at $200,000,000, with an annual cost for maintenance of $2,000,000; assuming an interest charge of 3 per cent., the total annual cost would be $8,000,000, which, according to the report, would have to be carried by a traffic estimated roughly from present conditions at 24,000,000 tons per year, corresponding to a saving of 33⅓ cents per ton over existing methods of transportation.

In Major Symons's opinion, this saving is hardly to be expected in view of railroad competition, and it is his belief that the traffic would be better handled by a 16-foot barge canal, capable of bringing the merchandise from the lakes to New York, there to be reloaded in seagoing steamers. The cost of such a canal would be only about one-fourth that of the proposed ship canal, and could probably be carried out along the line of the present Erie Canal with a minimum of cost and a maximum of advantage.

Doubtless this will hardly meet the views of those who desire to see Chicago made a seaport, but, when all the points which Major Symons has so clearly set forth are impartially taken into account, the wisdom of his views will be admitted.

Rope Driving.

IN a paper presented before the American Society of Civil Engineers upon the subject of "Rope Driving," Mr. T. Spencer Miller offers some points of undoubted value. It is well known that the driving power of a rope acting around a pulley is governed by two main factors,—the arc of contact which the rope makes with the pulley, and the angle of the groove in which the rope runs. Now, as most rope-drive installations are made where the driving and driven sheaves are of unequal diameter, and several turns of one continuous rope with tension carriage used, the various parts of the rope are found not to pull equally, a few of them doing the greater part of the work; the required tension therefore is greater than that which would be necessary if the work were more equally distributed.

Mr. Miller proposes to remove this inequality by varying the angle of the grooves in the two pulleys, in proportion to the difference in the arcs of contact, so that the strains in the various parts of the rope shall be equalized; and by this simple and ingenious method he remedies what has until now been the chief cause of loss and wear in multiple-rope transmissions.

It is not difficult to show by a concrete example how, with an equalized distribution of tensions, either the strain on the rope may be greatly reduced, giving a higher factor of safety and longer life, or, by maintaining the same tension, a corresponding increase in transmitting capacity may be gained.

For general purposes, the angle of 45° for the grooves has been found by experience to be the sharpest permissible, a more acute angle causing the rope to wedge too tightly and necessitating too much force to pull it out of the grooves at each revo-

lution. Assuming, then, 45° as the angle for the grooves in the smaller pulley, and using a well-known formula for finding the frictional grip for any other angle, the angle for the larger pulley can at once be computed to give a grip on the larger pulley corresponding to the arc of contact.

The method is open to the objection that the pulleys must be grooved especially for the location in which they are to be used, as the arc of contact varies both with the ratio of pulley-diameters and the distance between axes; but this is worth doing, if a continuous economy is thereby effected. The small pulleys can always be grooved to the standard angle of 45°, leaving only the large drivers to be finished when the data have been obtained, and usually such wheels are made to order in actual practice.

Since rope driving is very often used in transmissions involving great differences in pulley-diameters, such as from fly-wheel to jack-shaft, or from line-shaft to dynamo, this question of equalization of tension is one which has a most practical bearing upon rope transmission, and we believe that Mr. Miller has made a valuable contribution to the subject.

Hydraulic Dredging.

THE use of the modern hydraulic dredge has extended widely during the past few years, and an important descriptive and historical paper upon the subject has been presented before the Technical Society of the Pacific Coast, by Mr. W. H. Smyth, and printed in the *Journal of the Association of Engineering Societies* (Oct. 1897).

"The art of hydraulic dredging involves: (1) The mechanical severing of material from a water bottom; (2) the lifting of the severed material therefrom by atmospheric pressure; and (3) the transporting of it (mixed with water), by mechanical pressure, through pipes, to any desired place of deposit, these three processes constituting one continuous and connected operation."

The older forms of mechanical dredging were limited to the dipper, the clam-shell, and the endless-chain bucket. Suction pumping was first introduced for the purpose of lifting mud or sand, centrifugal pumps being used to draw the large volumes of semi-fluid material, and the water acting as a transporting material.

The modern hydraulic dredge,—as used extensively on the Pacific coast of the United States and elsewhere, is described by Mr. Smyth as the combination of a rotary excavator and a suction pipe, in which the material, when severed by the excavator, passes interiorly to the pipe.

In other words, the use of a rotary excavator, attached to the end of the suction pipe makes the sand or mud pump capable of handling material otherwise too solid to be separated by mere suction. The hydraulic dredge thus constructed has shown itself to be a machine of great efficiency and capacity.

Experience shows that the solid matter is carried along the lower side of the discharge pipe, and that it may be drawn off through openings in the under side of the pipe, while the bulk of the water flows out at the end, thus permitting the excavated material to be received in a sufficiently solid form for use in levee building and similar work.

The capacity to deliver solid material is naturally dependent upon the velocity of flow, and in some instances as much as 70 per cent. of solid material has been delivered at the discharge. In some cases large boulders have been brought to the surface, and almost any solid material, within the capacity of the pipe, when loosened by the excavator, may be lifted, if the velocity of the current is great.

In the discussion which followed the reading of Mr. Smyth's paper, Mr. A. B. Bowers, a pioneer in this work, gave some points connected with his experience. With discharge velocities of 15 to 20 feet per second, dredges of his design, of 400 h.p., have handled 100,000 cubic yards per month, the quantity depending upon the nature of the material. The general price for such work, when the material is to be delivered at a low elevation through a short discharge pipe, is about 15 cents a cubic yard. As Mr. Bowers well said: "The hydraulic dredge is a special tool for special work, and in its own sphere is without a rival."

Cantilever Foundations.

IN the construction of the modern tall building, the foundation upon which the steel cage or skeleton rests is one of the most important parts of the structure. In New York city, especially, the difficulties offered by the natural conditions of the ground are complicated by the necessity of under-pinning the adjoining buildings, the foundations of which are generally completely undermined. This adds largely to the cost of the work, and it is stated that in some cases the foundation work has amounted to 10 per cent. of the cost of the entire structure.

In order to avoid some of these difficulties, the cantilever system has been used, and in the *Engineering Record* (Nov. 27) an account is given of the application of this method by Messrs. Crehore and Miller to some stores in New York. Test boring having revealed rock foundations not far below the surface, cylindrical steel caissons were sunk to the rock, in pairs, the centres of the caissons being more than four feet from the wall line of the building. These were then filled with concrete, forming solid pillars entirely within the foundation area of the new building and having in no way undermined the adjoining structures on either side. As the width of the building was only 25 feet, two piers were sufficient for the width, and these were arranged six deep, making twelve in all. Upon each pair of piers a steel truss was placed, being in depth 10 feet, the full basement depth, and overhanging the piers at each end by the distance necessary to reach to the outer wall line,—in this case 4 feet 4⅛ inches at each end; upon the ends of these overhanging trusses the vertical posts of the steel cage rested.

The details of the construction are well shown in the article referred to, and the whole forms an admirable example of judicious engineering. The amount of overhang to the foundation trusses is so small that it is in no way prejudicial to the stability or strength of the structure which it supports, and the substitution of the cylindrical piers and the use of the steel caissons, avoided entirely the costly method of constructing a grillage over the entire area, or of sinking pneumatic caissons along the whole foundation wall line, including the care of adjacent structures during the operation.

Apart from the economy which this form of foundation effects, it is also worthy of consideration as an exceedingly reliable method, as the loads are concentrated upon points the integrity of which can be fully assured. It is evidently not adapted for doubtful or treacherous soil, and can be recommended only where the caissons can be carried down to bed-rock and an absolutely solid bearing obtained; but for such cases as are found in New York city the method offers advantages which will be evident to those who give the subject attention.

United States Gunboat Trials.

AN interesting comparative trial of two gunboats built for the United States government by the Union Iron Works of San Francisco is given in the *Journal of the American Society of Naval Engineers*, by P. A. Engr. F. C. Bieg, U. S. N., from which some notes are extracted.

The two vessels under consideration are the Wheeling and the Marietta, and, as the report says: "These vessels are as alike in hull and engine dimensions as they can be built." The dimensions are very fully tabulated, and longitudinal and midship sections are given, together with photographs of the engines and full data of the motive-power machinery. The general dimensions are: Length, 174 feet; beam, 34 feet; depth, 22 feet 7 inches; displacement, 996 tons. The speed was to be 12 knots. The twin-screw engines are of the usual inverted, direct-acting, triple-expansion type, with cylinders 12, 18, and 28 inches in diameter by 18 inches stroke, and intended to develop 800 h. p. at 200 revolutions, with steam at 180 pounds.

With one exception the machinery of both vessels is the same. The original design called for two cylindrical boilers, 10 feet 6 inches in diameter and 10 feet 6 inches in length, with a total heating surface of 2,508 square feet and 60

square feet of grate-surface. Such boilers were placed in the Wheeling, but, at the request of the contractors, two water-tube boilers of a well-known make were substituted, with a heating surface of 3,620 square feet, and a grate-surface of 98 square feet.

The two gunboats, then, were exactly the same in every respect, excepting the boilers, and hence the conditions were admirably suited for purposes of comparison.

The data of the speed trials are very fully given in Mr. Bieg's paper, from which it appears that the conditions were very nearly the same for both vessels throughout. With a speed of 230 revolutions there was developed in one case 1,024 h. p. and in the other 1,051 h. p., and the speed of the Marietta was 13.02 knots, and that of the Wheeling 12.88 knots. In the Wheeling the Howden system of forced draft was used, while in the Marietta the air pressure was delivered direct to the ash pits. In the case of the Marietta an air pressure of 0.36 inches was used, against 0.78 inches for the Wheeling,—a natural consequence of the difference in grate-area.

So far as economy is concerned, the trials were distinctly favorable to the tubular boiler. According to Mr. Bieg, the quantity of coal consumed per hour, for the Marietta (water-tube boiler), was 2,300 pounds, and per i. h. p. 2.18 pounds, while, for the Wheeling, the corresponding values were 1,855.5 and 1.72 pounds respectively.

Mathematics for Engineers.

THE *American Electrician* for December contains an article by Mr. Townsend Wolcott with the above title, which contains so many good points that it should really be read entire, placing, as it does, the much-discussed subject of the practical value of mathematics in a clear and intelligent manner before the general reader.

As an example of the value of mathematical knowledge to the electrical engineer, for example, Mr. Wolcott says: "Any one who can read Maxwell's treatise understandingly, or who, not understanding all of it, can understand the more essential parts of it, will find that there is an immense amount of later literature that is only necessary because the great majority of those who study electricity cannot read Maxwell. Thus is the advantage of a mathematical method of treatment of physical science exemplified. After a quarter of a century of progress in that particular branch of science, which is phenomenal in its magnitude, we can go back to the beginning of that period and find much of what is commonly called new discovery, in the original edition of a treatise on that science."

Mr. Wolcott has many good words for some of the older mathematical treatises, and with some degree of justice he says: "It is more important to have a good book on mathematics than a modern one, and several modern books run to fads rather than to sober science.

"It is not merely the ability to calculate that constitutes the utility of mathematical knowledge to the engineer; it is also the increased capacity for understanding the natural phenomena on which the engineering practice is based.

"It is evident that the advantage to an engineer of understanding a work like Maxwell's is not lost, even if he never uses any of the mathematics for the purpose of numerical calculations. As long ago as the days of ancient Greece, Aristotle said: 'I find the young men who study mathematics quick and intelligent at other studies.'"

But, apart from the value of mathematical studies as a mental training, the modern engineer, whatever branch of the science he may pursue, will find mathematics one of the necessary tools of his profession. This is especially true as the increasing magnitude of modern undertakings carries him far beyond the range of the empirical methods by which former practice was so largely guided. Former experience is an excellent guide, when used with judgment, but it will not do to carry proportions deduced from empirical data very far from the limits of the original observations. When we have deduced the equation of a curve, we can construct

the curve as far as we wish, but he is a bold man, having "the courage of his ignorance," who puts much confidence in a prolongation of any empirically-deduced curve beyond the range of the data on which it is based. Mathematics can never give you back more than is put into them, although they can teach much that would otherwise not be discoverable, and—what is often quite as valuable—enable false deductions to be detected. Almost as much depends upon the user as upon the method, and it has well been said that "figures will not lie, but that liars will figure."

The Purification of Feed-Water.

AMONG the papers presented at the convention of the American Society of Mechanical Engineers at New York, and forming a portion of the *Transactions* (Dec., 1897), one by Howard Stillman, upon a water-purifying plant, elicited much discussion, and demonstrated that the evils of boiler scale are appreciated by many steam users and engineers.

The plant described by Mr. Stillman is one installed by the Southern Pacific Railroad Company at Port Los Angeles, California, for the purification of feed-water to be used by the locomotives on that division. The plant is of interest because of the bad quality of the water treated, there being a large proportion both of carbonate and sulphate of lime and magnesia present, and also because it is a practical working installation in constant and continuous service, about which definite and trusworthy data are available.

The method employed consists of a double treatment of the water, with cream of lime and with carbonate of soda, the reagents being added successively in order to obviate the direct formation of carbonate of lime, which would otherwise occur by the combination of the two reagents with each other. The exact treatment of the water is determined by chemical analysis, after which the necessary amounts can be weighted out and used for each tank full of water. Two purifying tanks are used, the lime being added first, and the precipitated carbonates permitted to settle out, after which the liquid is passed to the second tank and the soda added.

The result is the removal of most of the carbonates and the conversion of the sulphate of lime and magnesia into sulphate of soda, the incrustating matter being reduced from nearly 40 grains per gallon to about 10 grains, and in practice the scaling in the boilers being practically stopped.

The question of the real advantage of purifying the water before feeding it into the boiler is one which elicited some discussion in connection with this paper, and, notwithstanding the objections made to "turning the boiler into a chemical laboratory," several engineers asserted that practical experience showed no harm from the addition of the soda directly to the feed-water in the boiler.

The real criticism of the method lies in the fact that it only partially acomplishes the desired result, leaving fully one-fourth of the scale-forming constituents still present, and reducing the quantity of solid matter in solution by only about twenty per cent. While this may be the best that can be done in purifying water in stock for locomotive water stations, as good if not better results can be accomplished by the use of high-temperature heaters and purifiers, precipitating the sulphates by the use of high-pressure steam in a closed heater.

THE BRITISH PRESS.

The Engineers' Strike.

THE contest between the Amalgamated Society of Engineers and the Employers' Federation reached an important stage in the proceedings when the conference early in December was held, and although the conference itself was without immediate result, so far as a settlement is concerned, yet it cleared the atmosphere to a very great extent by defining explicitly the positions and responsibilities of the two great parties to the struggle.

Nominally, the question at issue is that of the hours of labor; actually, it is the question of the control of management; and upon such an issue it is almost needless to say the sense of a great majority of the community is that the position of the employers, in standing out for the control of the management of their own establishments, is entirely just.

At the conference the question of the hours of labour was hardly mentioned, but instead, the employers submitted a number of propositions practically constituting their ultimatum, and as these propositions were such that the representatives of the men felt unable to accept without referring them to the rank and file of their organization, which has rejected them, the whole matter remains in suspense.

The employers propositions, in substance were these: I, entire freedom of employment to workmen and employers alike, union and non-union men to work in harmony together: II, the use of piecework to be permitted to any employers or men who may desire it, the piece-rate to be fixed individually between employer and workman: III, the maximum overtime limit to be forty hours in any four weeks, except in case of breakdown, repair, or similar emergency work: IV, every workman to be paid according to his ability, the rate of wages being a matter of individual agreement between employer and employed, this being accompanied by a disclaimer of any intention on the part of the employers to reduce wages: V, no limitation to be placed on the number of apprentices: VI, the employers to have entire control of the manner in which machine tools shall be worked, including the right to encourage ability wherever found, paying the men according to their individual ability. To these was also appended a proposition for the avoidance of further disputes, providing that local employers receive local deputations of workmen, before the question is submitted to the central authorities of the respective organizations, and that, during such discussion, no stoppage of work shall occur.

It is to be presumed that these propositions fairly represent the position of the employers, and indeed, according to the *Times*, the employers offer them as final, holding that "they will not depart from them by one jot or tittle, and that they feel that the engineering trade of the country cannot be carried on unless they carry their point."

On the other side the workmen, as represented by the *Daily Chronicle*, see in these proposals a demand that they "give up every substantial safeguard that unionism has won during the last two generations," and "combination for all effective purposes is to be wiped out in the engineering trade." So far as the proposals are concerned the men have, by practically a unanimous vote, rejected them *in toto*.

Meanwhile the industries of the country are languishing, and foreign competition continues. This phase of the situa- is plainly expressed by the employers. In reply to the claim of the men that the eight-hour day should follow as the consequence of the increased efficiency due to improved machinery, the federated employers maintain that whatever gain is obtained from this source is necessary to assist in meeting the pressure of increasing competition. "Although the trade of this country is still supreme over that of other countries, the alarming extent to which

orders are passing from us proves that our supremacy is rapidly diminishing. While our trade increases at a certain rate, that of almost every other civilized country is increasing in a far greater proportion, and, therefore, foreign competition cannot be dismissed as a bugbear."

The contention of the men is that they can follow their trade where it may go and, for example, find employment in the United States should orders go there. This side of the subject is clearly discussed in a letter to the *Times* from Mr. Angus Sinclair, the editor of *Locomotive Engineering*, of New York, himself well acquainted with industrial conditions on both sides of the Atlantic. After noting that within a single week fifty-eight locomotives for European railways had been placed with American builders, Mr. Sinclair refers to the idea of British workmen that they can follow their work to America and says that in such case:

"They will have to greatly change their ways to secure steady employment. Instead of an eight-hour day they will be glad to remain in the shop 56 to 60 hours a week," and, if employed on day work, "they will discover that they cannot push a file or wield a scraper with deliberate leisure," or they will find the foreman asking if they "intend working all the week on that two hours' job." Indeed, in the hustle of an American shop, the English mechanic soon gets rid of his deliberate movements and becomes as nimble as his companions, and before long is very glad to have an opportunity of tending several almost human automatic machines at piece-work rates, which pay him far better than day's work, for all the fact that he is a skilled workman. As the matter now stands, an early settlement, which it was hoped the conference would bring about, appears as far off as ever, and in the meantime the grasp of foreign competitors on trade, formerly wholly British, is becoming more and more firmly fixed.

That the men can win seems beyond the bounds of reasonable expectation; the principal danger lies in the possibility that they may cripple, not only their employers, but the industries of their country before a satisfactory conclusion is reached.

Unreasoning in the exercise of its strength, under a strange misconception of the relation of the workman to his employer, labor threatens to play the rôle of the blind Samson who may bring down the house above him in his fall.

Acetylene Mixtures.

EVER since the introduction of acetylene as an illuminant attempts have been made to dilute with other materials, This has been tried for two reasons—one to reduce the cost of the illuminating medium, and the other to enable it to be used in burners of larger opening than is possible with the pure acetylene. Practical difficulties have interfered with the use of acetylene as an enricher of ordinary coal or water gas, as the two illuminants will not combine readily, the mixture showing a tendency to separate and decompose. Air has been suggested as a diluent, but the obvious danger of keeping such a mixture in a gasholder has led to the devising of burners for the purpose of making the desired mixture at the point of ignition.

None of these plans has proved satisfactory in actual use, but now Professor Vivian B. Lewes, in a recent lecture, noticed in the *Gas World*, says that he has found methane to be a satisfactory diluent for use with acetylene. A mixture of 10 per cent. of acetylene, 30 per cent. of methane, and 60 per cent. of either hydrogen, carbon monoxide, or water gas. will give a light of 20 candles, and behave in every way like ordinary coal gas. He estimates that this mixture could be sold for 3s. 6d. per thousand, and the very high explosion temperature renders it entirely safe.

It is probable that acetylene will ultimately be used as an enricher for other gases, and probably the combination will be effected by some intermediate substance, like methane. It seems, however, as if a cheaper mixture than that above given might be made the vehicle for dilution and a greater economy realized; otherwise the competition of incandescent gas burners would be a serious factor in opposition to its success.

The Proper Study of Architecture.

PROFESSOR Aitchison, in his presidential address before the Royal Institute of British Architects, and printed in the *British Architect* (Nov. 5), gives utterance to some very wholesome truths about the study of architecture, which will well bear repetition and emphasis here.

Going straight to the root of the matter, he demands that architectural students learn architecture itself, not merely about architecture,—the art, not of imitating past work, but of creating present structures. To quote the words, not of an architect, but of an eminent American engineer referring to a similar subject, the student should be taught "what to do, and how to do it, rather than merely what has been done and who did it."

Says Professor Aitchison: "Looking at the enormous extent of knowledge required by an architect, and the almost antagonistic power of mind required, would it not be better to confine architectural teaching to architecture? As architecture is pre-eminently a constructive art, construction should certainly be its foundation,—the very last thing that would be thought of now, for the æsthetic architect would leave that to the builder and engineer. It seems ludicrous not to insist on the architect who is to build having such a knowledge of statics as to know the proper method of resisting the force of the wind, of water, and of earth, and the thrusts of arches, vaults, and domes. Statics would give us, too, important lessons in æsthetics, for it gives us the proper proportions of each part of a building when we know the height, the weight to be carried, and the strength of the material to be used. When these particulars are known and provided for, we may roughly say that we have only to accentuate the important part by mouldings, or have them adorned by the sculptor, to make them into architecture."

But it must not be forgotten that architecture is something more than a mere science; it is also an art; and, like all true art, to be successful it must affect the emotions as well as the reason. "Knowledge of the means used to produce emotions will not give the power to produce them, or else all the real critics of æsthetics would be poets, painters, sculptors, architects, or musical composers as well."

Here comes in the question of that undefinable quality which, for lack of a better name, we have called genius; and genius in architecture is not greatly different from that in any other branch of art. Many men may be taught the principles of statics and the laws of proportion, and many mediocre works will continue to be produced by careful students of such principles. The man of genius, too, will study, and profit by all that he has been taught, but he will put a new life into the dry bones which have been furnished him, and will render back far more than he has received from his instructors.

No man has yet suggested that art schools can create great painters, or that musical conservatories can produce masters of composition and harmony. The laws, so far as we know them, can be taught indeed, but the material to which the laws must be applied can come only from the inspiration of the user, or from the store-houses of the past. He is truly fortunate who possesses the true genius of art to originate genuine ideas for the present, and he should be doubly careful who, lacking original inspiration, must borrow from the works of those who have gone before.

Electro-Chemical Progress.

THE commercial application of electro-chemistry has been slower than most of the other developments of electricity, but it is now progressing at a rate which bids fair to make up for its former tardiness. An excellent view of the present state of electro-chemistry in England is given in an article by Mr. Bertram Blount in the *Electrician* (Nov. 12).

Electro-chemical processes have, until recently, labored under the disadvantage of suspicion. The capitalist has doubted the commercial practicability of methods demonstrated only on a laboratory scale, but the success which has attended elec-

tro-chemical methods in Germany and in the United States has removed much of this suspicion, and, as Mr. Blount remarks: "The conversion of the capitalist is the most significant achievement of the modern electro-chemist." Now, however, the barrier of timidity has been overcome, and "any electro-chemical process which can be shown to work well on a small scale, and is favourably regarded by an independent and competent consultant, will not go long a-begging. It will be taken up, not necessarily in England, but on the continent or in America, and a trial on a practical scale accorded to it. Should this prove successful, manufacturing in earnest will be begun, and no capital expenditure, however large, is likely to deter the true merchant-adventurer."

The oldest and largest branch of the art is the refining of copper, which must be sharply distinguished from the winning of copper from its ores by electrolysis. Electrolytic refining is a complete and colossal success, while the electrical reduction of the metal from the ore has not yet passed the experimental stage. Refining zinc by electrolysis is not likely to be a success commercially, because of the ease with which the metal can be purified by distillation; but, on the contrary, the electrolytic winning of the metal from the ore appears to offer many advantages, and several successful processes are on the market.

Sodium and aluminum are both well known as electro-chemical products, and the electrolytic production of alkali and chlorine is a branch of the art which is making daily progress.

Naturally the cheapening in the production of electricity is an important factor in the development of electro-chemical industries, and it is a noteworthy fact that the utilization of natural sources of power has resulted not so much in attracting existing industries as in the building up of new businesses depending upon the direct use of electric current without any intermediate conversion into force in motion.

"The present situation of electro-chemical industry may be summed up in a few words. The refining of copper is a thorough success, and its ultimate predominance is assured; the winning of zinc is about to come; the aluminum industry is on a firm and broad basis; sodium can be made cheaply, but wants buyers; soda and chlorine products are just rounding the corner, and their manufacture is being seriously undertaken; the coöperation of the capitalist in all reasonable enterprises has been secured. There has been much solid progress, and we may fairly look for further and substantial advances in the near future."

Diagram Accounts.

THE use of curves or irregular lines, plotted from numerical data, is a method of recording and investigating relations which has deservedly become popular in many branches of applied science.

Mr. John Jameson has recently applied the method of diagrams to the recording and comparison of cost accounts, and his paper before the recent meeting of the Institution of Mechanical Engineers, printed in *Engineering* (Nov. 12), contains some excellent points. Mr. Jameson truly says: "Few things are of more importance than a ready and accurate system of prime-cost accounts. By promptness and accuracy in ascertaining cost, the net result on the completion of every contract or piece of work done is at once brought clearly before the management; and the profit or loss shown serves as a guide for the acceptance or rejection of other contracts or other work. Usually the elimination of unprofitable orders, and the cultivation of profitable work directed by actual knowledge of cost, are alone more than sufficient to justify the comparatively small expenditure involved."

After enumerating the essential elements of a good cost system, including closeness to date, balance, detection of error, individual machine accounts, and separation of manufacturing from commercial trading, Mr. Jameson goes on to show how applicable the diagram system is for the purpose desired.

Every engineer is familiar with the manner in which the indicator diagram shows

the relations between pressure and volume at every point of the stroke. "Precisely what an indicator diagram does in exhibiting the performance of a steam engine, a set of properly-constructed account-diagrams will do in disclosing the economic working of a manufacturing concern, in all that pertains to the actual manufacturing costs."

The diagrams proposed by Mr. Jameson are of several kinds, examples being given in the article to which reference has been made.

In the machinery-employment diagram the vertical ordinates represent the percentage of possible earnings of a class of machines, such as lathes, planers, or boring machines, the abscissas representing time, either weeks or months, so that the curve for any class of machines shows at once the proportional activity. As the lines interfere but little, several curves may be carried upon one sheet, and the general condition of the various earning elements of a shop revealed at a glance.

"The varying results of five or ten years' work can be exhibited upon a single sheet in a few lines, the direction of which indicates their import." By assuming a base line, the various fluctuations can be reduced to percentages. The several lines relating to machinery charges, establishment charges, wages, and store issues are then combined into a line of total costs. The interval between this line and the straight line denoting 100 represents the percentage of profit, where below the straight output line, and the percentage of loss, where the total costs exceed the output. Such a review furnishes data of great value for comparison with present operations, and fixes in the mind broad general principles of practical importance. A number of practical examples are given in the paper, showing the method of applying the system, together with conclusions drawn from the diagrams, modifications being readily made to meet the requirements of special conditions.

In concluding, Mr. Jameson says:

"One advantage in a good series of diagram accounts extending over a period of years lies in its showing that extreme over-pressure of work is too costly; extreme deficiency of work is ruinous; between them somewhere lies a mean, at which the highest profit may be made. It is important, therefore, that this mean should be ascertained, and then that it should at all times be as nearly as possible maintained. Good management should be judged, not by the mere profit made, but by the profit viewed in the light of the favorable or adverse circumstances under which it has been made."

This latter condition is one which is too often overlooked, and, indeed, without some graphical display of the work of past years and the conditions of present production, it is hardly possible to grasp fully the innumerable factors which enter into such a comparison.

Whatever the fundamental system of cost accounts used in an establishment, the reduction of the data thus obtained to the graphical form can hardly fail to render much more information than could possibly be gathered from them in tabular arrangement.

High-Speed Locomotives.

EVER since the first publication of the account, in various technical journals, of the excellent speed made by the Atlantic City express of the Philadelphia & Reading Railway during the summer of 1897, there has been more or less discussion in the columns of the British engineering journals upon the subject. In one or two instances the accuracy of the report was questioned, and the curious statement somehow got into print that in the United States the mile contained only 5,000 feet instead of the orthodox 5,280, while from numerous correspondents exclamations of incredulity were published.

For a time it looked as if the once almost interminable discussion of English versus American locomotives was to be reopened, and the old straw thrashed over once more.

This appeared the more unnecessary because no claim was made for extraordinary speed in itself, for this especial train, the published report rather dwelling upon

the fact that the speed scheduled had been maintained during the entire summer without failure, and that this daily express train had not been late once.

Among the incredulous journals was *The Engineer*, in whose columns much of the correspondence upon the subject appeared. In its recent issues *The Engineer* (November 12 and 19, 1897) gives letters from Mr. Clement Stretton, an English engineer familiar with railway practice in the United States, together with an editorial reviewing the matter very fully. Although Mr. Stretton did not ride on the Atlantic City express during the last summer, he fully accepts the authenticity and accuracy of the report, especially as it agrees closely with figures obtained by himself from the same road under similar conditions in 1893.

At that time the entire run of 55½ miles was made in 55¼ minutes, the fastest mile being made in 44 seconds, or at the rate of 81.8 miles an hour, while the fastest mile of the past summer was made in 43 seconds—a rate of 83.7 miles an hour.

Commenting upon Mr. Stretton's letter, the *Engineer* says in its leading editorial (Nov. 19, 1897):

"We have done all that lies in our power for a long time past to arrive at the truth, and, although we cannot claim to have been very successful, we have ascertained that it is true that speeds are attained in the United States which are not attained here, and apparently cannot be attained."

The highest speeds attained in Europe are supposed to be those in the trials between English and French locomotives just after the last Paris Exposition, this being about 125 kilometers, or 77.5 miles per hour. After comparing the structural differences between the two types, the editorial proceeds: "The more carefully we examine the facts, the more difficult do we find it to explain why an American engine should run faster than an English engine. The only theory which promises to repay investigation is that the American locomotive is superior as a vehicle to the English engine."

There is one feature about the Reading engine which the *Engineer* apparently fails to note. The locomotive, which was a Baldwin Vauclain compound, was constructed with the Wooten boiler, common to most of the Reading engines, and possessed the superior steaming power which comes from the large fire-box and increased grate-area which that type permits. While we have no official data upon the subject, it is our belief, gained from a personal knowledge of Reading engines in general, and this Atlantic City train especially, that the high speed so successfully maintained was very largely due to the ability of the boiler to generate steam faster than the cylinders used it.

Electrical Traction.

An editorial in the *Practical Engineer* (Nov. 5) gives a very fair account of the present status of the mechanical traction problem for tramway service, especially in connection with the various local investigations made during the past few months by municipal commissions and borough engineers.

It seems to be generally admitted that Britain has not been so active as the continent or the United States in the adoption of mechanical substitutes for animal traction, and, this being the case, it is eminently wise to investigate the experience of others, and profit by their successes and failures. In Great Britain, as in other countries, there has been, and still is, a strong prejudice against the overhead trolley, but from many sources of information we are led to believe that this prejudice is weakening, in view of a more thorough knowledge of what has been accomplished elsewhere. Referring to this portion of the subject, the article in the *Practical Engineer* continues:

"In various parts of this country we have a few mechanical lines, but the proportion is exceedingly small. The cable, gas, electric conduit, overhead trolley, and steam have all their representative systems, but, from what one hears from day to day, it is clear that the battle of the systems is resulting in the victory of the overhead trolley, in spite of its objections. We believe that we are correct in saying that nearly every deputation has

returned fully convinced of the serviceableness and economy of that system."

In this respect the various British municipalities are doubtless in much the same position as were many cities in the United States when the problem of electrical traction was presented to them. The overhead trolley, objectionable though it was on æsthetic grounds, offered the only solution of the question at all within the limits of commercial practicability. Those cities which adopted it have an economical, efficient, and rapid system of transit, accompanied, it is true, by the defacements which accompany, to a greater or less degree, the use of the overhead wires. Those cities which rejected it have until now struggled along with continually-increasing congestion of their main thoroughfares, and are now, in one notable instance at least, expending large sums for underground systems. The lesson from American experience England may readily learn, and, seeing the alternative, may choose intelligently. Overhead systems will do the work and do it well, and, where there is ample room, and where reasonable care is exercised, the unsightliness of poles and conductors may be very greatly diminished. Underground trolleys will do the work equally well, and without creating any eyesore, but only those who can afford the cost should consider them.

The Measurement of Wind Pressure.

In many engineering structures the force of the wind is an important factor to be taken into account in proportioning the strength of the various parts, and in some large work the wind stresses are among the greatest which the structure is called upon to resist.

Various methods have been devised for measuring the force of the wind, and, while some of these have been found acceptable for meteorological purposes, they have failed to give just the information which the engineer should have.

The Robinson cup anemometer, well known to all visitors to meteorological stations, is generally accepted as the most reliable apparatus at present in use, and the steady revolutions of the arms bearing the four hemispherical cups give a very fair measure of the mean velocity of the wind, especially when the instrument has been carefully calibrated on a sufficiently large whirling machine, and its individual coefficient determined. Even assuming the record of such an apparatus to be correct, however, it does not give the data in the form required for engineering purposes. The record of the Robinson apparatus shows the velocity in miles per hour during the period over which the observations extend. But this is only an average, and it is well known that the velocity is far from uniform, even over a small period of time; hence the maximum velocity must be some unknown quantity materially greater than the mean value thus determined.

Engineers, therefore, should be interested in a new form of anemometer, devised by Mr. W. H. Dines, a member of the Royal Meteorological Society, described and illustrated in *The Engineer* (Nov. 19). This apparatus is constructed somewhat on the same principle as that of the Pitot tube, used for measuring the velocity of water.

"The instrument may be briefly described as follows. The head consists of a vane, formed of a piece of tube with an open end, which is kept facing the wind, and into which the wind blows, while just below the vane is another and larger tube, perforated by several holes arranged in rings, the action of the air in blowing across which is to suck out the air from the inside. These two pipes are separately connected with soft metal pipes, which are led down to the recording apparatus wherever it may be placed."

The record produced by such an instrument is practically similar to that of other recording pressure gauges—*i. e.*, it shows all the fluctuations of pressure during the interval in which it is exposed, and also the suddenness and rapidity with which the changes of pressure occur. From such a record the engineer can obtain ample information concerning the forces to which any exposed structure may be subjected, and by preliminary exposures

over a sufficient length of time the probable maximum pressures for any given locality may be determined.

Anemometers of this kind have been erected in various parts of Great Britain and the continent, as well as in India and Japan, and it is not unlikely that some form of apparatus constructed on this principle may supersede the rotating anemometer for meteorological observatories.

Fire Protection in London.

THE recent disastrous fire in London calls attention to the fact that the fire department of the metropolis has hardly progressed as rapidly as has the great city which it is intended to protect. In commenting upon the facts, *Engineering* (Nov. 26) says:

"The lesson is that we seem to know very little about fire protection in London, and that, the sooner we take up the matter, the better for all concerned, more particularly if we remember the rate at which the metropolis is growing in extent, the greater costliness of our structures, and their contents."

After referring to the condition of the London fire department at the time of the death of Mr. Braidwood, and the energetic efforts of Sir Eyre M. Shaw to develop its efficiency while he held office, the article referred to shows that the present force and equipment are barely equal to-day to what Sir E. M. Shaw thought necessary even in 1872, notwithstanding the enormous growth of the area requiring protection.

Continuing, the paper in *Engineering* says:

"But, after all, no matter how strong the brigade, and how well organized and handled, we shall continue to have our large fires until fire-*prevention* has been given the attention it demands. It would be absolutely impossible in twenty years' time, as to-day, and with the best aid from brigades skilfully handled, to prevent a fire spreading from one feather warehouse to another, if these two have a common area of only a few feet width, and under such circumstances have not even adopted the makeshifts of iron shutters to their windows. We shall even then not be able to prevent a fire which breaks out in the ground floor from destroying the whole building, if we simply have cast-iron columns, girder work, or so-called 'fire-resisting' construction, which has that quality only in name. If we have party-walls for warehouse property, why should these have to encounter the strain of iron work expanding and contracting from the fire? Why should they not be taken up higher than is requisite at present? In fact, there are a hundred questions which do not receive our serious attention, and to the neglect of which we must ascribe, in the first place, such conflagrations as the Cripplegate fire."

In all this criticism, the right keynote has been struck. Fire protection will always be necessary so long as the remains of earlier buildings exist and antiquated methods of construction are retained, and no efforts should be spared in all great cities to keep the fire protection up to the highest degree of efficiency, both in *personnel* and equipment. But fire-prevention is the theme which should be urged continually, and should ever be before the eyes of building inspectors and ordinance makers. The right of one man to imperil his neighbour's property should be denied or restricted wherever possible, and no more important function of the engineering profession exists than that of keeping the servant, fire, from becoming master.

THE CONTINENTAL PRESS

Compression in Steam Cylinders.

THE subject of clearance in steam engines, and the extent to which the losses due to clearance may be reduced by compression, is one which has been discussed and studied, both theoretically and experimentally, by many able engineers. As long ago as 1869 Zeuner enunciated the statement that, when the expansion is complete, a complete compression will entirely overcome the injurious effect of clearance. By a complete expansion Zeuner meant such a degree of expansion as makes the terminal pressure equal the back pressure; and by a complete compression that which causes the steam confined in the clearance space to attain the initial pressure.

Prof. Dwelshauvers-Déry discusses the subject in a very valuable paper in the *Revue de Mécanique* for October, and shows that, while the dictum of Zeuner may be theoretically true under the ideal conditions assumed, it may be shown to be in error when all the conditions actually existing in a working cylinder are taken into account and especially when cylinder condensation is considered.

If Zeuner's position is correct, the volume of the clearance space is a matter of no consequence whatever, and, instead of using all care and skill to reduce the clearance, engine designers might simply adjust the valves so as to give the proper degree of compression, whereby the desired result would be accomplished. The experimental tests of Hirn and Hallauer, as well as the practical experiences of engine builders, however, showed that the volume of clearance space does have a marked effect upon steam-consumption, even when high compressions are used, and, with but few exceptions, designers of steam engines continue to keep the clearance volume as small as is mechanically practicable.

In order to investigate this subject further, Professor Déry has made, at the University of Liège, in Belgium, a very careful series of experiments. These were made with the experimental engine at Liège, and it is interesting in this connection to quote Professor Déry's words:

"Hirn had many doubts, which his engine was powerless to solve. From this fact originated my own great desire to possess in a laboratory, with other instruments of precision, an experimental engine free from the trammels of factory demands and limitations, and flexible enough to be operated at any arbitrarily-selected points of cut-off and compression. To create such a laboratory capable of solving this and many other questions,—this was my dream, encouraged by Hirn. It may be a matter for astonishment that the realization required twenty-four years! To obtain the engine took eleven years of effort, nine years more were required to get the laboratory, and three years of experience to attain a degree of precision necessary to obtain satisfactory results. To-day, the mechanical tests made in our laboratory are such as to inspire thorough confidence in the results."

With this apparatus, and with a profound knowledge of the work of his predecessors, Professor Déry proceeded to investigate the behaviour of steam in a cylinder, and the results of his investigations, conducted in March, 1897, are given in the *Revue de Mécanique*.

The experiments included tests made with degrees of compression varying from zero to $\frac{4}{10}$ of the stroke, and indicator diagrams and heat measurements were taken with carefully-calibrated instruments, all conditions other than those under experimental investigation being kept practically constant. The results, which are both tabulated and plotted in curves, are most instructive, and demonstrate that the steam-consumption increased 57 per cent. when the compression increased

from zero to $\frac{4}{10}$ of the stroke, and that this increase followed a regular law for the intermediate points of compression.

The cause of this loss is found in what Professor Déry calls the *anticipatory* condensation. The loss from the initial condensation of the live steam on entering the cylinder is greatest when there is no compression, and is diminished as the clearance space is filled with compressed exhaust steam; but the rate of this diminution is small compared with the loss which takes place by the condensation of the compressed exhaust before the point of admission is reached.

When the general loss from internal condensation is considered, the injurious effect of excessive clearance adds a factor which compression can only partially reduce, while Professor Déry's experiments reveal losses from this anticipatory condensation of the compressed exhaust which increase very rapidly with increase of compression. This action is also shown by the indicator cards, and verified by the concurrence of all the phenomena as the tests were repeated.

At first the compression acted to superheat the steam, the condensation beginning as the velocity of the piston diminished and showing its most energetic action when about 95 per cent. of the stroke was accomplished.

Professor Déry announces additional researches on the above lines, the results of which will be awaited with much interest.

A New Method of Testing Materials.

A SIMPLE method of testing metals in order to ascertain, not only the strength, but also the ductility and elasticity, was presented before the French Academy recently by M. Maurice Levy, and is described in *Comptes Rendus* (October 4.) The method, which is due to M. Fremont, consists in applying bending pressure to the test-piece, the latter being in the form of a prismatic bar, supported on roller bearings at each end in such a manner as to be free to yield to the action of the bending force applied at the middle point above. The section of the prism is reduced for a certain portion of its length, in order to limit the zone of yield, and the polished sides of the piece are marked with fine parallel lines, at uniform distances apart, and ruled at right angles to the length of the test-piece. When the piece is bent, these lines are distorted according to the deformation of the bar, and from the changed position of the lines the behaviour of the metal is ascertained.

By photographing the bent test-piece, usually on a magnified scale, a permanent record is made, and from such photographs comparisons between different specimens may be made in such a manner as to enable practical conclusions to be drawn very readily.

The ease with which the tests can be made, and the simple apparatus required, make the method particularly applicable for practical shop-use, where elaborate testing-appliances are not available.

Electrical Transmission in Workshops.

UNDER the title, "A Modern Machine Shop," a description is given in the *Zeitschr. des Vereines Deutscher Ingenieure* (October 23) of the works of Kolbern & Co. at Prag-Visocan in Bohemia, and, as the establishment is an excellent example of electrical transmission in shops, some of the details are of present interest.

The establishment is devoted to the manufacture of dynamo-electric machinery,—that is, to the production of moderate-sized machine work, the entire power of the engine being but 60 h. p. The machine shop is 72 feet by 200, divided longitudinally by a row of columns into two bays, each covered by an electric traveling crane, one of 3 and the other of 5 tons' capacity.

The entire power of the engine is used to drive a three-phase generator with a normal capacity of 50,000 watts. The current generated is divided into two portions, one of 200 volts' pressure for power purposes, and one of 100 volts, used for lighting. Each of the larger tools has its individual motor, and the special arrangements of the various tools show the care which has been given to the installation. In the case of a heavy 7-foot lathe, the

motor is placed in the foundation, being, with its gearing, entirely enclosed and protected, a belt from its cone pulley driving the corresponding cone on the lathe. The high speed at which it is advisable to run the motors makes it necessary to gear down, and a general arrangement of self-contained motor and countershaft has been designed, the motor, gearing, and pulleys all being mounted upon one base in a form capable of being readily adapted for use with any machine tool.

The numerous small tools are grouped, and driven from a single line shaft, operated by its own motor, it being found better to do this than to use very small motors for the purpose.

The establishment contains at present twenty motors of various sizes, ranging in capacity from ¼ to 6 h. p. with a total of 38 h. p. The entire cost of these motors was less than the cost of three lines of shafting, each 200 feet long, with the hangers, couplings, and pulleys required by the old method of driving. It is claimed also that experience has demonstrated the running expense to be less with electric driving than with shafting, the cost of lubrication, wear and tear of belts, losses from journal friction, etc., all being eliminated by use of the electric system.

The Caillet Monorail.

VARIOUS forms of single-rail tramways have been devised from time to time, but most of these have failed to come into general use, mainly because their projectors attempted too much and brought the one-rail system into antagonism with the regular double-rail track. M. Caillet has been more modest, and for that reason may be more successful, as in his so-called "monorail" system, illustrated and described in *La Revue Technique* (November 10), he aims to produce only a portable and temporary tramway for industrial and agricultural purposes.

For such service the single track is especially suitable. There is no difficulty of maintaining uniform gauge or double grade, and the single track can be run quickly and conveniently in localities where a double track would be objectionable or difficult.

The cars for use on the monorail are very simple and convenient, consisting mainly of a pair of beams running parallel beneath the platform, and a single wheel between them at each end. The load is piled on the platform, with reasonable care in distribution, so as to "trim ship," and the horse is attached on one side, the harness being so arranged as to prevent tipping. A driver may ride on the car or walk beside, as occasion may indicate, and the platform may be replaced by box or barrow, according to the character of the load. Smaller cars for hand propulsion are made; some of the larger ones have a capacity of one-and-a-half tons.

The great facility with which this portable road can be put down and started in immediate operation is its principal claim to notice. Neither grades or curves offer material obstacles to its use, as it can be carried over rough country with ease. Three men can readily bend a single rail to any desired curve, and, as there is no importance attached to the exact degree of curvature and no companion rail to match, there is little trouble on that score.

Single-rail roads of this construction have found successful application in Egypt, Mexico, and the French colonies, as well as in the agricultural districts of France, while for military purposes there is no doubt of the availability of the system.

The Strength of Cylinder-Heads.

THE modern theory of the strength of materials makes it possible to compute with a reasonable degree of accuracy the strains and stresses in various portions of a structure when all the conditions are sufficiently well known to be taken into account. In many cases, however, it is not practicable to determine the conditions accurately beforehand, and recourse must be had either to empirical formulas or to constants deduced experimentally.

Sometimes also the correct theoretical relations may be obtained by judicious experimental investigations; such a case is

found in the recent and very thorough experiments of Prof. C. Bach upon the strength of flat plates, such as the heads of steam cylinders, boilers, drums, and similar constructions.

Prof. Bach is already well known by his valuable treatise on the elasticity and resistance of materials, and these later investigations, published in the *Zeitschr. des Vereines Deutscher Ingenieure* (October 9, 16, and 23) are quite in the line of his former work.

The experiments were made on a large enough scale to be of direct practical value, the trial-cylinder being nearly 28 inches in diameter, and the general arrangement of parts reproducing fairly well the conditions of general practice. The stresses were applied by hydraulic pressure, and a rigidly-supported system of contact pins enabled accurate measurements of the bulging deformation to be made as the successive pressures were applied. Preliminary tests were made to determine the influence of changes of temperature upon the measuring apparatus, but, by maintaining nearly a uniform temperature in the apparatus, errors from this source were practically eliminated.

The tests were made at pressures progressing from one to twenty-five atmospheres (using the metric atmosphere of 1 kg. per sq. cm=14.22 lbs. per sq. in), and very full tables of the deflections under these conditions are given by Prof. Bach. The materials, having been previously tested for strength and elasticity, gave additional data for the verification of the theoretical treatment, so that the whole mass of results furnished ample material for mathematical discussion.

In this discussion Prof. Bach bases his computations upon the well-known formula for a beam fixed at both ends, and deduces from his experiments values for coefficients for heads of different shapes and materials. He takes occasion to oppose the theory of the late D. K. Clark that the resistance to bursting pressure varies as the thickness simply, and shows that his experiments sustain the general view, denied by Clark, that the resistance varies directly as the square of the thickness.

Altogether, Prof. Bach has not only added to the stock of knowledge concerning a special detail of construction, but has also shown how a series of experimental investigations should be conducted, and—what is still more important—how to use data thus obtained.

The New Faidherbe Bridge.

FRANCE has not been altogether successful in her attempts to develop her colonies, but it can hardly be said that this is due to neglect on her part, and the work which has been done and is still progressing in her possessions on the west coast of Africa is certainly worthy of encouragement, and should strengthen her position there materially.

We have already referred in these pages to the progress of the Senegal-Niger railway, and we now have to notice the new Faidherbe bridge, recently completed to connect the island of St. Louis with the main land. A very full description of this work is given in *Le Génie Civil* (October 23), with illustrations of the completed bridge and drawings of details.

The city of St. Louis, the capital of the French possessions on the Senegal coast, is situated on an island, which, since 1865, has been connected with the main land of Africa by a pontoon bridge across the wide arm of the Senegal river. This bridge owed its origin to General Faidherbe, then governor of the colony, and it has since been known by his name.

The constant increase in travel resulted, in 1892, in a decision by the colonial government to replace this primitive construction by an iron truss bridge of a permanent character, and this work, for which the contract was let in 1894, has now been brought to a successful completion.

The new bridge contains, in addition to a wagon-way and two sidewalks, a railway track of 1-meter gauge, the entire roadway being 7 meters in width.

The total length of the bridge is 506 meters (1,660 feet), divided into five stationary spans of 77 meters each, one swing draw of 71.5 meters, and one shore span of 43 meters; each being composed

of a lattice truss with the bottom chord horizontal and the top chord a parabolic curve.

Owing to the peculiar conditions, the construction of the bridge involved some difficult problems. The piers were constructed by the use of compressed air in metallic caissons, which were sunk to a depth of 20 meters below the surface of the water before a suitable foundation was assured, the main pier for the swing truss being 9 meters in diameter. The depth of the water rendered the construction of false works difficult; hence, instead of being supported on piles, the trusses were assembled upon timber supports carried by floating pontoons anchored between the piers. This method was especially applicable, since the bottoms of the trusses were only about eight feet from the surface of the water, and the tidal differences small.

The general designs for the bridge, and the computations for the various members, were made under the direction of M. Résal, of the *Ecole des Ponts et Chaussées*, and, in spite of the climatic difficulties, the work was completed within the contract time by the builders, MM. Noguier and Kessler, of Argenteuil.

Metallography as a Method of Research.

A NUMBER of important and valuable papers were presented at the meeting of the International Association for Testing Materials at Stockholm, and among them may be noted the communication of M. F. Osmond, of Paris, upon "Metallography," or the study of various metals by the appearance of their etched sections. From this paper, as given in *Stahl und Eisen* (November 1), we make some extracts, referring the interested reader to the publication for further details.

Mr. Osmond ingeniously compares a chemical analysis of a metal, such as a steel or an iron, with an analysis of an organic substance, such as a bone, and maintains that, while such an analysis may convey some information, it is of small value without a corresponding knowledge of the accompanying physical structure.

Knowing as we do the different behaviour of metals of practically the same chemical composition, it must be admitted that anything which will enable structural differences to be st ıdied is of great importance. The use of the etching of metal to show the texture of steel is by no means new, and, indeed, the waving lines upon a Damascus sword-blade are produced by a similar process; but Mr. Osmond proposes to systematize the subject into a complete science. Following out the analogy to living matter, the author divides the subject into anatomical, biological, and pathological metallography, dealing with the structure, the normal variations, and the ailments, so to speak, or abnormal variations of metals, as revealed by the physical behaviour of sections submitted to the action of corrosive agents, and studied under the microscope.

Mr. Osmond gives full credit to the pioneers in the study of the physical characteristics of metals,—Prof. Martens, Dr. Wedding, Prof. Guillemin, Dr. Sorby, and others,—but his own efforts to reduce the subject of metallography to a scientific system have added much to the independent work of his predecessors. The paper is illustrated with some admirable reproductions of micro-photographs of etched sections, showing very clearly the changes in structure caused by changed conditions of temperature and treatment.

Mixtures of Iron and Steel.

IT has occasionally been the practice of some foundrymen to add either to the cupola charge or to the molten cast iron in the ladle a certain proportion of steel scrap, it being claimed that stronger castings were thus produced. The *Moniteur Industriel* (October 23) describes some tests of such mixtures from the experiments of M. Vinsonneau, the castings consisting of a metal produced by adding 20 per cent. of bessemer or open-hearth scrap in the cupola.

The tensile strength of the product was found to be about 17,000 pounds per square inch, while a number of drop tests under various conditions showed a resistance to shock two to five times that of the cast iron without the addition of steel.

Castings from this metal also showed excellent quality for wearing surfaces, and M. Vinsonneau suggests its use for guide bars, large bearings, and the like.

The most important point to be observed is the thorough mixture of the materials, in order that the resulting product shall be as homogeneous as possible; for this purpose either the materials should be well mixed in the charge, or, better still, the melting should be performed in a furnace of the Pernot type with revolving inclined hearth.

Owing to its strength against shock, this mixture is well adapted for frame castings of heavy machinery.

Photographic Altitude Measurements.

THE use of exploring balloons and kites has mainly been devoted to meteorological investigations, but the necessity of determining the altitude attained by the recording instruments used in such work has resulted in the development of several independent methods of altitude measurement. Primarily the recording barometer is considered the altitude gauge, either for kite or balloon, the formula of Laplace in some one of its later revised forms being applied in the computation, together with the necessary instrumental corrections. In order to avoid entire dependence upon the barometer, the altitude has also been determined by measuring the length of cord in the case of a kite, using a measuring reel, and taking the angle from the reel to the kite, with proper correction for the length of the catenary.

At the session of the French Academy for October 26, M. Cailletet presented an account of another method, which is of value for several reasons. This method, described in *Comptes Rendus*, is based upon the automatic photography from the kite or balloon of two base stations, on the earth. The distance between the stations, and the focal length of the photographic objective, being accurately known, the altitude from which the photograph was taken can be found by simple proportion, from the distance between the images of the two base stations.

M. Cailletet has arranged such a device in connection with an auxiliary apparatus, by which the dial of an aneroid barometer is photographed upon the same film as the base stations; hence the altitude may be computed by both methods for the same instant. By having the film fed and the camera shutter operated automatically, at uniform intervals of time, a succession of images for different altitudes is obtained, and the correctness of the barometric indications may be verified by the measurement of the photographs.

A series of twenty-six photographs taken with this apparatus has been successfully worked up, and a similar apparatus is being designed to record the horizontal distance of the kite or balloon from a given base.

Among the practical results obtained by these experiments may be noted the verification of the barometric formula as used for the measurement of altitudes, and the general applicability of photography for similar measurements in other lines of work. A further communication from M. Cailletet will be looked for with interest.

Sewage Purification at Spandau.

THE city of Spandau, near Berlin, discharges its drainage into the river Havel, which in turn empties into the Elbe, and the number of cities located on both rivers below Spandau rendered it most desirable that the sewage should be purified before entering the stream. This subject was considered when the present sewerage system was planned in 1890, and since 1895 the purification plant has been constructed, and is now in successful operation. An excellent account of the method, including details of construction and cost, is given by Herr Pfeffer, in the *Gesundheits-Ingenieur* to which reference should be made for a full description.

The general method adopted is that of clarifying the sewage by use of a solution of chlorid of iron, which precipitates the albuminous matter and phosphoric acid, and also checks the formation of sulphuretted hydrogen and sulphid of ammonium, thus removing much of the foul odor. Further

purification is effected by the addition of carbon in the form of finely-powdered lignite or brown coal, and a proportion of milk of lime is also added to assist in the precipitation.

The chlorid of iron solution is cheapiy prepared by treating bog iron ore with crude hydrochloric acid, and this solution is used in the proportion of fifty grams to the cubic meter of sewage, while about three times as much milk of lime is added. The lignite breeze is finely ground in a mill and mingled with water to the extent of 12 to 13 per cent., forming a liquid of about 7° Beaumé density; and this is added to the sewage in such quantity as to correspond to about 1.5 kilograms of coal dust to the cubic meter of water. Instead of chlorid of iron, the oxy-sulphate of iron may be used, in the proportion of 200-300 grams to the cubic meter of sewage. The liquid is then passed into suitable settling-tanks, from which the solid matter is drawn off from time to time by a system of suction chambers, and delivered to a filter press, where it is compressed into blocks suitable for burning.

It is found by experience that, for every 100 parts of solid matter added to the sewage for purification purposes, 160 parts are obtained in combustible blocks from the filter press, so that 60 per cent. of the matter has been abstracted from the sewage.

The plant at Spandau has been constructed in accordance with experience gained with similar methods used at Potsdam and at Leipzig, and in the latter city the investigations of Prof. Dr. Fr. Hofmann showed excellent results, so far as the sewage purification is concerned.

Some general idea of the cost of such a plant may be obtained from the actual figures given for this installation. At Spandau the sewage had to be elevated ten to twelve feet, in order to obtain the necessary fall, and this is included in the cost; but, as this is often the case elsewhere, these figures will also be of interest. The plant provides for a population of 75,000, allowing 6.5 liters per hour of sewage per head, and a dilution of 2.7 times, which corresponds roughly to 100 gallons per head every twenty-four hours. For this installation the machinery, including engines, boilers, centrifugal pumps, transmission, etc., cost £2,400 ($11,800), while the purifying portion, including buildings, came to £3,900 ($19,000); adding a miscellaneous account of about £200 ($1,000), the total cost is seen to be £6,500 ($31,800).

The Cost of Power.

THE industrial applications of electricity, and the necessity of generating current at as low a power-cost as possible, have led to renewed efforts to reduce the cost of obtaining motive power; especially when large units, such as are usually required for electric stations, are considered.

The *Zeitschrift für Elektrochemie* (October 5) contains an elaborate and important article by Herr Chr. Eberle, of Duisburg, upon the subject of power-cost, in which detailed comparisons are made between steam and gas-motors, the results being tabulated for units of 200, 400, 600, 800, and 1,000 h. p., for 365 days of 24 hours, and for 300 days of 11 hours.

For the 200-h. p. steam plant a compound engine is considered, having a consumption of 14.5 pounds of water per horse-power hour, while for the larger units a triple-expansion engine is considered, with a consumption of 11.7 pounds. The gas engines are supposed to be operated with power gas, generated in producers from coke, or anthracite, or both. In tabulating the various items, Herr Eberle has made careful allowance for interest and depreciation, and has based his costs upon well-ascertained prices of existing plants. For steam plants this was not difficult; for power gas motor plants the data obtainable from the Bâle waterworks plant and other similar installations furnished the best figures available.

As might be expected, the superior economy of the gas motors is most apparent with the higher cost of fuel, and, with coal at the lowest price taken by Herr Eberle,— *i. e.*, 6*s.* 6*d.* or $1.55 per ton,— the advantage is in favor of steam, while, with coal at 16*s.*, or $4.00, the gas motors show a higher economy.

Thus, with coal at the higher price the cost with steam, for a 200-h.p. plant, would be £6 5s ($30.30) per h. p. per year of 300 days at 11 hours per day, while for power gas under the same conditions the cost would be £4 15s ($23.30) per year. With coal at the lowest price of 6s 6d ($1.55) per ton, other things remaining the same, the computed costs are £4 4s ($20.30) and £3 17s ($18.60) per h. p. per annum for steam and gas respectively. It is only for very large units that the steam engine approaches the gas engine for economy, and this is doubtless due to the fact that for 1000 h. p. a single steam engine can be used, while a gas plant involves the use of five gas motors of 200 h. p. each, at least until the builders of gas engines are prepared to furnish larger sizes.

In this connection, however, we may add that one of the most important advantages of gas as a source of motive power has been overlooked. With the best modern producers it is by no means necessary to use a high-grade fuel, and, while the steam generator may be obliged to use a good quality of coal, the producer can be operated with low-grade slack, costing little more than the cost of transportation. With the latest improvements in gas engines, such as Herr Diesel has lately made public, and with the use of gas producers capable of utilizing low-grade slack and culm, the most economical steam engine will be badly distanced by the gas engine under any circumstances.

It has been contended by some engineers that good results cannot be obtained with gas engines when so poor a gas is used as that which is obtained from low-grade fuel, gasified in a producer without enrichment, but the experiments made in Belgium using the waste gases from blast furnaces directly in gas engines certainly prove the contrary.

According to a paper by Prof. Hubert, of Liège, in the *Annales des mines de Belgique* good results have been obtained. Thus ordinary gas engines have been satisfactorily operated with blast furnace gases analyzing:

Nitrogen	51.51
Carbonic Acid	16.78
Carbonic Oxid	23 98
Hydrogen and Hydrocarbons	1.07
Moisture	6.66
	100.00

Taking into account the calorific value of the gas, the efficiency of the engines averaged 13 per cent., which is very much better than could be obtained by burning such a gas under steam boilers and using the steam to operate steam engines.

When the capabilities of the gas engine are more thoroughly appreciated and a wider experience has been had with large motors and power-gas generators, the cost of power will undoubtedly be greatly reduced, in comparison with the above figures.

THE ENGINEERING INDEX

INTRODUCTORY

This Index is issued separately from the Magazine, printed on one side of the paper only, and is supplied to subscribers for THE ENGINEERING MAGAZINE at a nominal charge of fifty cents a year to cover cost. In this form it meets the exact requirements of those who desire to clip the items for card-index purposes.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 15c. The letter A, B, or C denotes a price of 30 cts.; D, of 45 cts.; E, of 60 cts; F, of 75 cts.; G, of 90 cts.; and H, of $1.25. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

The titles and addresses of the journals regularly reviewed are given in full below, but only abbreviated titles are used in the Index. Other abbreviations employed are: Ill=Illustrated; W=Words; Anon=Anonymous.

To avoid the inconvenience of small remittances, and to cheapen the cost of articles to those who order frequently, we sell the coupons which are represented here in miniature.

The price of these coupons is 15c. each, or fifteen for $2, forty for $5, and one hundred for $12.

This Coupon
will be received by us in payment for any 15 cent article catalogued in "The Engineering Index" of the ENGINEERING MAGAZINE. For articles of a higher price, one of these coupons will be required for each 15 cents: thus a 30 cent article will require two coupons, a 45 cent article three coupons, and so on.
The Engineering Magazine, New York:
Please send Article No. _____ to the following address:
Facsimile
Not Good

With a supply of these coupons on hand, no letter writing is required. Simply fill in the number and your address. A stamped envelope does the rest.

This system is strongly commended to our readers. The coupons need only a trial to demonstrate their convenience.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

Age of Steel. *w.* St. Louis, Mo.
American Architect. *w.* Boston, Mass.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven, Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila., Pa.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Atlantic Monthly. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Journal. *m.* London
Bankers' Magazine. *m.* New York.
Bankers' Magazine. *m.* London.
Bankers' Magazine of Australia. *m.* Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* Berlin.
Board of Trade Journal. *m.* London.
Boston Journal of Commerce. *w.* Boston, Mass.
Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila., Pa.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington, D. C.
Bulletin of the Univ. of Wisconsin, Madison, Wis.
California Architect. *m.* San Francisco, Cal.
Canadian Architect. *m.* Toronto, Ont.
Canadian Electrical News. *m.* Toronto, Ont.
Canadian Engineer. *m.* Montreal, P. Q.
Canadian Mining Review. *m.* Ottawa, Ont.
Century Magazine. *m.* New York.
Chautauquan. *m.* Meadville, Pa.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington, D. C.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago, Ill.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineer. *w.* New York.
Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.

Elektrotechniker. *b-m.* Vienna.
Elektrotechnischer Anzeiger. *s-w.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Engineer. *w.* London.
Engineer. *s-m.* New York.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering Assn. of the South. Nashville, Tenn.
Engineering and Mining Journal. *w.* New York
Engineering Magazine. *m.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
Fire and Water. *w.* New York.
Forester. *bi-m.* May's Landing, N.J.
Fortnightly Review. *m.* London.
Forum. *m.* New York.
Foundry. *m.* Detroit, Mich.
Garden and Forest. *w.* New York.
Gas Engineers' Mag. *m.* Birmingham, England.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glasers Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Gunton's Magazine. *m.* New York.
Harper's Weekly. *w.* New York.
Heating and Ventilation. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *w.* Calcutta.
Indian Engineering. *w.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago, Ill.
Iron Age. *w.* New York.
Iron and Coal Trades' Review. *w.* London.
Iron & Steel Trades' Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal Franklin Institute. *m.* Phila., Pa.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q* New London, Conn.
Journal Political Economy. *q.* Chicago, Ill.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
Journal Western Soc. of Eng. *b-m* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kan.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore, Md.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Master Steam Fitter. *m.* Chicago, Ill.
Mechanical World. *w.* London
McClure's Magazine. *m.* New York.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, Pa.
Mining and Sci. Press. *w.* San Francisco, Cal
Mining Industry and Review. *w.* Denver, Col.
Mining Journal. *w.* London.
Mitt. aus d. Kgl. Tech Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. Stuttgart.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, Ind.
National Builder. *m.* Chicago, Ill.
Nature. *w.* London.
Nature. *w.* Paris.
New Science Review. *qr.* New York.
New Zealand Mines Record. *m.* Wellington, N. Z.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Physical Review. *b-m.* New York.
Plumber and Decorator. *m.* London
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineer's Club. *q.* Phila., Pa.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago, Ill.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago, Ill.
Railway Review. *w.* Chicago, Ill.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revue Technique. *b-m.* Paris.
Sanitarian. *m.* Brooklyn, N. Y.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerisches Bauzeitung. *w.* Zurich.
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Scientific Machinist. *s-m.* Cleveland, Ohio.
Scribner's Magazine. *m.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga.
Stahl und Eisen. *s-m.* Dusseldorf.
State's Duty. *m.* St. Louis, Mo.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J.
Stone. *m.* Chicago, Ill
Street Railway Journal. *m.* New York
Street Railway Review. *m.* Chicago, Ill
Technology Quarterly. Boston, Mass.
Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* New York
Transport. *w.* London.
Western Electrician. *w.* Chicago, Ill
Western Railway Club, Pro. Chicago, Ill.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, Conn.
Zeitschrift für Lokomotivführer. *m.* Hannover.
Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ingen. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.
Zeitschrift für Instrumentenkunde. *m.* Berlin.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Art Building.

New York's New Art-Academy Building. Edwin Emerson, Jr. Information concerning this building, with illustrations of the accepted design. 1200 w. Harper's Wk—Nov. 27, 1897. No. 16798.

Bank.

A Bank and Safe-Deposit Building. Illustrated description of the recently-constructed building for the Security Trust Company, of Rochester, N. Y. 700 w. Eng Rec—Nov. 6, 1897. No. 16350.

Birmingham, Eng.

The Architecture of Birmingham, England. Critical description of the buildings, old and new, with illustrations. 4800 w. Builder—Nov. 27, 1897. No. 16998 A.

Fireproofing.

Fireproof Buildings. Comments on the severe tests of recent fires on this style of structure, discussing the Manhattan Bank, New York, the fires at Pittsburg, Pa., and Detroit, Mich. Ill. 1200 w. Fire & Water—Oct. 30, 1897. No. 16260.

The Present Condition of the Art of Fireproofing. Peter B. Wight. Discussion of this question, with favorable comment on the use of burned clay. 2000 w. Br Build—Nov., 1897. No. 16890 C.

Foundations.

Cantilever Foundations for Small Buildings. Describes the unusual conditions existing in the city of New York, often making secure founda- a matter of great expense, and gives a plan resorted to in the case of steel structures of moderate size. Ill. 1600 w. Eng Rec—Nov. 27, 1897. No. 16878.

Healthful Construction.

Building Construction and Public Health. Peter Fyfe. Extract from an address under the auspices of the Glasgow Master Wrights' Assn. Deals with the essentials of a healthy house. 1400 w. Arch, Lond—Nov. 5, 1897. No. 16665 A.

Hotel.

Mechanical Features of the Hotel Touraine. Describes the general arrangement of rooms, electric wiring, and plumbing of a new Boston hotel. Ill. 2400 w. Eng Rec—Nov. 6, 1897. No. 16351.

Jail.

The Fulton County, Georgia, Jail. Part first consists of general description, giving floor plans, elevation and sections. 1200 w. Eng Rec—Nov. 13, 1897. Serial. 1st part. No. 16639.

Observatory.

A Famous Astronomical Observatory Built of Brick and Terra-Cotta. Illustrated description of the observatory given by Charles T. Yerkes, to the University of Chicago, and located at Lake Geneva. 1000 w. Brick—Nov., 1897. No. 16395.

Prison Construction.

The Steel Cell and Central Corridor System of Prison Construction. Illustrated description of method adopted in the Erie County Penitentiary at Buffalo, N. Y. 1100 w. Sci Am—Nov. 27, 1897. No. 16801.

Romanesque.

The Metropolitan Church of S. S. Rupert and Virgilius at Salzburg in the Romanesque Period. (Die Metropolitan-Kirche St. Rupertus und Virgilius zu Salzburg in Romanischer Zeit.) A valuable review of the development of the Romanesque school of ecclesiastical architecture with examples from various churches of southern Germany. 7500 w. Oesterr Monatscher f d Oeffent Baudienst—Nov, 1897. No. 16418 D.

Schools.

The American School House. Edmund M. Wheelwright. Part first compares the planning of German and American schools, and discusses sizes of rooms, light, ventilation, &c. Ill. 3300 w. Br Build—Nov., 1897. Serial. 1st part. No. 16889 C.

Tall Buildings.

The Tall Building from an American Point of View. A. D. F. Hamlin. A rejoinder to a previous paper by Prof. Capper, defending the tall building and showing the practicability of treating it in a satisfactory manner architecturally. The tall building is bound to remain in use, it is for the architect to meet the conditions which confront him. 3500 w. Engineering Magazine—Dec., 1897. No. 16896 B.

Town Hall.

The New Municipal Buildings of Suresnes. (Les Nouveaux Edifices Communaux de la Ville de Suresnes.) An illustrated account of the new town-hall of Suresnes, near Paris, with a description of the handsome electric-lighting plant. 1800 w. La Revue Technique—Oct. 25, 1897. No. 16426 D.

HEATING AND VENTILATION.

Columbus, Ohio, Depot.

Heating and Lighting Plant of the Columbus, O., Union Depot. Illustrated detailed description. The Webster steam-heating system is used, which involves the extreme use of the vacuum principle. 2300 w. Eng Rec—Nov. 20, 1897. No. 16729.

Dust Abatement.

Dustless Buildings. C. J. Woodbury. Describes a device for removing the annoying dust from the air in large buildings, caused by methods of heating and ventilation. 800 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16820 D.

Heat Calculations.

An Attempt to Systematize Calculations Where Heating is to be Accomplished Entirely or Partly by Air Introduced for Ventilation. H. Eisert. The object of the paper is to define the

relations to each other of those conditions which must be considered wherever heating is to be accomplished by this method. 2500 w. Heat & Ven—Nov. 15, 1897. Serial. 1st part. No. 16702.

Hot Water.

Hot Water Heating of a Danbury, Conn., Business Block. Describes the heating of the Nichols Block. The overhead system of supply is employed, and the heater is placed on the first floor, there being no basement. Ill. 600 w. Eng Rec—Nov. 13, 1897. No. 16640.

Library Heating.

The Heating and Ventilating of the Library of the University of Illinois. James M. White. The system adopted is the "plenum" or fan system. The conditions to be complied with are given, with illustrated detailed description of work. 1800 w. Heat & Ven—Nov. 15, 1897. No. 16700.

Pipe Capacity.

The Capacity of Pipes to Convey Steam. E. C. Sickles. Describes some experiments made to determine friction of steam in wrought iron pipes, and discusses some of the results obtained. 1800 w. Sib Jour of Engng—Oct., 1897. No. 16863 C.

Residence.

Heating Residence of Thomas M. Turner, Esq. Illustrated description of a type of rural-residence heating quite prevalent in many parts of the United States. 700 w. Heat & Ven—Nov. 15, 1897. No. 16701.

Ventilation.

Pure Air in a Telephone Building. Describes the unusual means to accomplish this end, resorted to in the new telephone building in Cleveland, O. Ill. 700 w. Eng Rec—Nov. 27, 1897. No. 16881.

LANDSCAPE GARDENING.

Parks.

New Dangers to Public Parks. Editorial discussion of the various dangers which threaten parks. 1500 w. Gar & For—Nov. 10, 1897. No. 16549.

Trees.

Autumn Work Among the Trees. Editorial suggestions on tree-planting in the north. 1000 w. Gar & For—Nov. 3, 1897. No 16318.

PLUMBING AND GASFITTING.

Inspection.

Baltimore Plumbing Inspection. James C. Mitchell. Records the beneficial results in that city from the intelligent supervision established. 2200 w. Dom Engng—Nov., 1897. No. 16703 C.

Plumbing Ordinance.

New Plumbing Ordinance in Peoria, Ill. Given in full as a model for other cities. 6500 w. San Plumb—Nov. 1, 1897. No. 16327.

School House.

School-House Plumbing in Cold Climates. Describes a system installed at Red Wing, Minn., devised to meet all conditions of weather. Ill. 1100 w. Met Work—Nov. 20, 1897. No. 16713.

MISCELLANY.

Aberrations.

Architectural Aberrations—585-87 Broadway, New York. Remarks on the changes wrought in middle Broadway, N. Y., between Canal and 10th Streets, and its faulty architecture, with special criticism of the building named. 2500 w. Arch Rec—Oct.-Dec., 1897. No. 16334 C.

Address.

Presidential Address of Prof. Aitchison before the Royal Institute of British Architects. Considers the means of advancing the art and profession of architecture. Also discussion. 7800 w. Builder—Nov. 6, 1897. No. 16661 A.

Campanile.

Peruzzi's Campanile at Siena. W. P. P. Longfellow. Interesting account of the work of this noted architect of the Renaissance. Ill. 3200 w. Br Build—Nov., 1897. No. 16888 C.

Churches.

St. Mary's, Oxford. Arthur Edmund Street. Review of work by T. S. Jackson, with something of the history of the church. Ill. 2400 w. Jour Roy Inst of Brit Arch—October 14, 1897. No. 16675 D.

Ecclesiastical Architecture of Scotland. Review of a book by David MacGibbon and Thomas Ross, with critical remark. Ill. 1800 w. Builder—Oct. 23, 1897. No. 16252 A.

Parochial Churches. Oswald J. Reichel. Extract from a paper read before the Devon and Exeter Architectural Society, England. Some of the peculiar architectural features of these churches, with interesting information. 1700 w. Builder—Nov. 13, 1897. No. 16721 A.

Classification.

A Proposal for Classifying Builder's Work. S. Flint Clarkson. Read before the London Architectural Assn. Considers why this is desirable and suggests classes to be made. Short discussion. 2100 w. Arch, Lond—Nov. 12, 1897. No. 16734 A.

Cliff Villages.

Account of an Expedition to the Cliff Villages of the Red-Rock Country, and the Tusayan Ruins of Sikyatki and Awatobi, Arizona, in 1895. J. Walter Fewkes. Reproduced from the Annual Report of the Smithsonian Institution for 1895. Descriptive. 4000 w. Brick—Nov., 1897. No. 16397.

Competitions.

Architectural Competitions. Russell Sturgis. A statement of a number of instances illustrating the failure to conduct competitions honorably, with discussion of the subject and of the essential conditions. 4500 w. Arch Rev—Vol. IV, No. VI. No. 16293 F.

Decoration.

Hall and Vestibule. Walter J. Pearce. Illustrated suggestions for the treatment of the walls. 1900 w. Plumb & Dec—Nov. 1, 1897. No. 16659 A.

The Interior Decoration of Churches. Ralph Adams Cram. Considers the elemental principles of church decoration, as drawn from the work of those ages when the Church was the dominant power in civilization. 3000 w. Arch Rev—Vol. IV, No. VII. No. 16867 F.

Materials.

Some New Building Materials. H. D. Searles Wood. Read at meeting of the Architectural Assn., London. Deals with asbestic and petrifite. 2400 w. Arch, Lond—Nov. 12, 1897. No. 16735 A.

Molding.

Esthetic Value of Molding and Profile. Joseph Venne. Read at Quebec Assn. of Architects. A brief review of the evolution of molding and profile as they appear in the monuments of different ages. 1100 w. Can Arch—Nov., 1897. No. 16770 C.

Mont St. Michel.

The Fortified Abbey of Mont St. Michel. Illustration and brief description of this wonderful and beautiful structure on the coast of Brittany. 1000 w. Eng News—Nov. 11, 1897. No. 16566.

Old English House.

Nevill Holt. Maud Cunard. Interesting illustrated description of an old English estate and some of its furnishings. 3500 w. Arch Rec—Oct.-Dec., 1897. No. 16333 C.

Painting.

See Civil Engineering, Miscellany.

Paris Bazaar.

The Paris Bazaar Fire. Edwin O. Sachs. Read at meeting of the London Architectural Assn. A careful discussion of this subject and of fire hazards in general, with the remedy needed to secure safety for large gatherings. Followed by discussion. 11000 w. Builder—Oct. 30, 1897. No. 16386 A.

Stairs.

Stairs. Fred T. Hodgson. Helpful suggestions on the design and construction of stairs. 5000 w. Nat Build—Oct., 1897. No. 16341 C.

Tarsney Act.

The Tarsney Act and the American Institute of Architects. Dankmar Adler. A discussion of the difficulties in the administering of this law. 1500 w. Inland Arch—Nov., 1897. No. 16668 G.

The Orient.

Oriental Architecture. Cyrus K. Porter. Traces the development of Saracen or Moslem architecture through its various stages, calling attention to its beauties. 8000 w. Stone—Nov., 1897. No. 16687 C.

Tools.

The Architect's Tools. Henry Rutgers Marshall. Discusses the tendency to over emphasize the importance of elevation drawings, and the means to be adapted to correct this fault. 4000 w. Arch Rev—Vol. IV, No. VII. No. 16868 F.

CIVIL ENGINEERING.

BRIDGES.

Arch.

Construction of a Forty-Foot Concrete Arch. C. H. Nicolet. Abstract of a paper presented at the Springfield meeting of the Illinois Society of Engineers and Surveyors. Descriptive. 1000 w. Eng Rec—Oct. 30, 1897. No. 16251.

East-River Bridge.

The New East-River Bridge Foundations. Describes the work on the New York side of this structure, especially the points that differ from the Brooklyn side. 2500 w. Eng Rec—Nov. 6, 1897. No. 16348.

Long Span.

Proposed 850-Foot Span Highway Bridge. Plans and specifications for a bridge across the Ohio River at Bellaire, O., were prepared and bids or designs for a cantilever and also for a suspension span invited. A comparison is made of the essential features of the two types available, with diagrams. 1500 w. Eng Rec—Nov. 27, 1897. No. 16875.

Old Bridge.

The Old National Bridge. Describes the bridge over the White-Water River, at Richmond, Indiana, which is soon to be replaced by a modern construction. Ill. 900 w. Pro of Purdue Soc of Civ Engs—1897. No. 16809 D.

Painting.

See Civil Engineering, Miscellany.

Railway Bridges.

Designs for Railway Bridges. Onward Bates. The subject is considered in a general manner. 13800 w. Pro of Purdue Soc of Civ Engs—1897. No. 16807 D.

Senegal.

The New "Faidherbe" Bridge at Saint-Louis. (Le Nouveau Pont Faidherbe à Saint-Louis.) A fully illustrated account of the new truss bridge across the Senegal, replacing the pontoon bridge connecting the island of the city of Saint Louis with the main land of Africa. 3500 w. 1 plate. Le Génie Civil—Oct. 23, 1897. No. 16422 D.

Suspension Truss.

The New Bridge over the Theiss at Tokay. (Die Neue Theissbrücke bei Tokaj.) Illustrated description of a suspended truss bridge on the cantilever principle recently completed at Tokay, in Hungary. The central span is 350 feet, and two side spans of 170 feet. 4500 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—Oct. 29, 1897. No. 16411 B.

Toronto.

The New York Street Bridge, Toronto, Canada. Illustrated description of the type known

as the "deck bridge." 300 w. Can Arch—Nov., 1897. No. 16771 C.

Trusses.

A Graphic Solution of Trusses. Fred Morley. A convenient method for determining the stress in any particular member of a roof or bridge truss. 2300 w. Pro of Purdue Soc of Civ Engs—1897. No. 16815 D.

CANALS, RIVERS AND HARBORS.

Breakwaters.

Breakwater Construction on the American Coast. Louis T. Schermerhorn. Extracts from a paper presented before the Engineers' Club of Philadelphia. Data of American experience and practice. 1000 w. Ry Rev—Nov. 13, 1897. No. 16655.

Bremen.

The New Harbor Works at Bremen and Bremerhaven. (Die Neuen Hafenanlagen in Bremen und Bremerhaven.) The official report of Herr Herbst, the chief engineer of the Austrian Department of the Interior, with plans of the docks and river improvements. 4000 w. Oesterr Monatschr f d Oeffent Baudienst—November, 1897. No. 16416 D.

Canal Outlet.

The Proposed Canal Outlet for the Birmingham (Alabama) District. W. M. Brewer. Describes a plan to connect this district with the Black Warrior River; a project of importance on account of the probable effect on freight rates. 500 w. Map. Eng & Min Jour—Oct. 30, 1897. No. 16262.

Dam.

The Moveable Dam on the French Meuse. (Eine Variation der Stauanlagen der Französischen Meuse.) Description of the combined needle and shutter dam for the control of the level of the river Meuse in connection with the Eastern Canal of France. 2000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Nov. 1897. No. 16417 D.

Docks.

Extensions of Liverpool Docks. Report of the works committee of the Liverpool Docks and Harbor Board. 1800 w. Arch, Lond—Oct. 22, 1897. No. 16286 A.

Dredging.

Hydraulic Dredging: Its Origin, Growth and Present Status. W. H. Smyth. Read before the Technical Society of the Pacific Coast. Discussion. Reviews briefly the salient points in the progress of this art. 10,000 w. Jour Assn of Engng Socs—Oct., 1897. No. 16792 C.

Fremantle.

The Port of Fremantle. Report of the rapid advance in the work being carried out at this port in West Australia. 2000 w. Transp—Oct. 22, 1897. No. 16285 A.

India.

Cocanada Harbor. Jas. R. Bell. Letter with notes on condition, value, and a description of Cocanada Bay. 1400 w. Ind Engng—Oct. 2, 1897. Serial. 1st part. No. 16503 D.

Sea Lock.

See Electrical Engineering, Power.

Sea Walls.

Sea Defences. Richard F. Grantham. Read before the Society of Engineers, England. A study of the principles upon which works for the protection of property from the sea should be constructed. 3700 w. Ind & Ir—Nov. 5, 1897. Serial. 1st part. No. 16613 A.

Ship Canal.

A Ship Canal from the Lakes to the Hudson. A summary of the findings and conclusions reached and discussed in the report of Thomas W. Symons, on the question of this American ship canal. 1100 w. Ir Age—Nov. 4, 1897. No. 16325.

A Ship Canal from the American Lakes to the Sea. Main conclusions of the report of Thomas W. Symons, with examination of the report in some detail, showing how the conclusions have been reached. 2700 w. R R Gaz—Nov. 5, 1897. No. 16369.

From the Lakes to the Sea. Carl Snyder. An account of the inventions and devices that have now rendered feasible a great ship canal connecting the Great Lakes in the United States with the sea. Reviews the importance of the freight question, and of the invention of the pneumatic, quick-acting, high-lift lock, devised by Chauncey N. Dutton. Ill. 9500 w. Am Rev of Revs—Nov., 1897. No. 16244 C.

Will a Ship Canal from the American Great Lakes to the Atlantic Pay? Abstract of the report of Thomas W. Symons, with editorial review of facts concerning the enterprise, and letters from engineers. Ill. 15000 w. Eng News—Nov. 11, 1897. No. 16572.

Shore Protection.

The Protection of Shores against Encroachments of the Sea. E. L. Corthell. Devoted especially to the dikes and shore protection works of Holland, and showing how with skilful guidance the sea may be made to build up the shore instead of eating it away. 3000 w. Engineering Magazine—Dec., 1897. No. 16894 B.

Towing.

Electric Towing on French Canals. Illustrated description of systems used, and experiments made. 700 w. W Elect'n—Oct. 30, 1897. No. 16310.

Wharf Improvement.

Modern Wharf Improvements and Harbor Facilities. Foster Crowell. With illustrations and descriptions of dry docks on both sides of the ocean, as well as floating docks, and the details of docking and overhauling vessels. 4000 w. Engineering Magazine—Dec., 1897. No. 16897 B.

IRRIGATION.

Dam.

The Muchkundi Dam. Illustrated description of a concrete dam in India, forming an irrigation reservoir intended to store water for distribution in the plains at a lower level. 800 w. Engr, Lond—Oct. 22, 1897. No. 16272 A.

Drainage.

Drainage and Irrigation Works in Mexico. Describes works for "unwatering" and also for rendering land fertile by bringing water on to it. Gives brief outline of early work in this region. 1500 w. Nature—Oct. 21, 1897. No. 16279 A.

Gagings.

Stream Gagings. Clarence T. Johnson. Explanation of methods as used in Wyoming. Ill. 2300 w. Pro of Purdue Soc of Civ Engs—1897. No. 16811 D.

Water Lifts.

Water Lifts. The results of Mr. Chatterton's experiments on the merits of the various kinds of water lifts used in India for agricultural purposes. Also describes a simple and ingenious machine easily and cheaply constructed and adapted to any well. Ill. 2000 w. Ind Engng—Oct. 2, 1897. No. 16502 D.

MISCELLANY.

Address.

Address by Sir John Wolfe Barry before the Institution of Civil Engineers, London. After discussing details of business routine, the question of a meeting hall large enough to receive the entire membership is broached; as well as a new model room to receive the increasing collection. 5500 w. Engr, Lond—Nov. 5, 1897. No. 16644 A.

Altitude Measurement.

Apparatus for Measuring Altitudes. (Appareil Destiné à Mesurer les Hauteurs, &c.) L. Cailletet. An apparatus for determining the altitude of a balloon by photographing two points on the surface of the earth. A simultaneous photograph of the barometer is also taken for comparison and verification. 1200 w. Comptes Rendus—Oct. 26, 1897. No. 16435 B.

Beams.

A Diagram for Determining the Size of Beams of Rectangular Cross Section. John H. Gregory. Diagram with explanation of its use. 300 w. Eng News—Nov. 4, 1897. No. 16364.

Cement.

Notes on Cement-Mortar and Concrete. (Betrachtungen über Cementmörtel und Beton.) Prof. A. Martens. An investigation of the relation between the sizes of the particles and the binding power in concretes of various composition; with tables of tests and other data. 10,000 w. 1 plate. Mit a d Kgl Tech Versuchsanstalt—Part II, 1897. No. 16445 F.

Notes on the Manufacture and Properties of Blast-Furnace-Slag Cement. A. D. Elbers. Criticism of article by Henri Détienne, in the *Revue Universelle des Mines*. 1100 w. Eng & Min Jour—Oct. 30, 1897. No. 16263.

The Adulteration of Portland Cement. Editorial on the investigations of Messrs. Stanger and Blount, presented in a paper read before the English Society of Chemical Industry. 1600 w. Engng—Nov. 5, 1897. No. 16621 A.

Explosives.

The Use of Explosives for the Production of Natural Drainage. (Emploi des Explosifs à la Constitution de Drains Naturels.) Describes the success which has been attained in some instances by the use of explosives for loosening the ground and breaking up clayey, water-tight strata. 2000 w. La Revue Technique—Oct. 25, 1897. No. 16428 D.

Foundations.

See Architecture and Building, Construction.

Framework.

The Double Console. (Die Doppelkonsole.) Luigi Vianello. A mathematical investigation of the distribution of forces in a framework composed of two horizontal truss beams with vertical connection. 3500 w. Zeitschr d Ver Deutscher Ing—Nov. 6, 1897. No. 16408 D.

Hydraulic Obstruction.

The Law of Hydraulic Obstruction in Closed Streams. David Guelbaum. Describes method of investigation which led to the discovery of this law. Ill. 1600 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16828 D.

Ideal Column.

Theory of the Ideal Column. William Cain. Analysis, also giving an expression for the maximum deflection for a load very slightly exceeding that given by Euler's formula, and confirming that formula as a practical one within the usual limits. 3400 w. Pro Am Soc of Civ Engs—Oct., 1897. No. 16229 F.

Iron Protection.

Bridge Painting by Air Blast. Description of the apparatus and its operation used in painting the One Hundred and Fifty-fifth Street viaduct, New York. 1100 w. Eng Rec—Nov. 13. 1897. No. 16636.

Oil Paints for the Protection of Iron, Steel, and Wooden Structures. M. F. Linsday. The importance of a knowledge of the materials used is shown, and information concerning oils is given. 2200 w. R R Car Jour—Nov., 1897. No. 16565.

The Protection of Iron by Paint. Embodies the results of investigations and remarks on the properties of a good paint and the best method of applying it. 2800 w. Engr, Lond—Oct 22, 1897. No. 16269 A.

Mortars.

The Influence of Sea Water on Mortars. E. Candlot. Abstract translation. Reports the investigations made in the harbor of La Rochelle since 1856, with discussion. 3000 w. Eng Rec—Nov. 27, 1897. No. 16876.

Photo-Surveying.

Vertical and Horizontal Angles in Photo-Surveying. Fred Morley. Directions for platting a topographical map by means of the photographic surveying camera. 2500 w. Pro of Purdue Soc of Civ Engs—1897. No. 16813 D.

Recreation Pier.

The Third Street Recreation Pier. A description of the most important features, with drawings of this New York pier, which combines commercial uses and free popular pavilions that will benefit the residents of the crowded tenement districts. 2000 w. Eng Rec—Oct. 30, 1897. No. 16250.

Roads.

Roads. Francis V. Greene. An address given before the students of Union College, Schenectady, N. Y., and printed in the journal of the Massachusetts Highway Assn. Extract. Discusses the relation which roads bear to civilization, and defines some of the principles in accordance with which they should be constructed. 4800 w. Brick—Nov., 1897. No. 16396.

Society House.

The New House of the American Society of Civil Engineers. Brief history of the society with illustration and description of their new building, 220 West 57th St, New York. 2200 w. Ir Age—Nov. 25, 1897. No. 16859.

Stress.

Moduli of Elasticity for Compound Stress. W. Hendrick Hatt. Deals with the behavior of flat plates in flexure. 2000 w. Pro of Purdue Soc of Civ Engs—1897. No. 16814 D.

Surveying.

A Military Survey Made with a Bicycle. An account of use made of a bicycle fitted with a cyclometer, to obtain distances, and of a military pocket compass, for directions, in very rapid surveying. 500 w. Eng News—Nov. 4, 1897. No. 16362.

Tunnel.

A Submerged Tunnel. Abstract of a paper, "A Study of a Proposed Method of Building a Submerged Tunnel," by James Cowan Meem. Read before the Brooklyn Engineers' Club. Describes a method applicable to any case where the bottom is not of extraordinary depth and is of such a character as to admit of its being dredged. 1200 w. Eng Rec—Nov. 13, 1897. No. 16638.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

American Trade.

Thirty Years of American Trade. Michael G. Mulhall. The development of the last quarter of a century; the American import trade, export trade, internal trade, and trade with various countries are discussed. 2700 w. N Am Rev—Nov., 1897. No. 16297 D.

British Colonies.

The Trade of the British Colonies. Michael G. Mulhall. A study of the development of the commercial relations based on statistics furnished by the Board of Trade, with conclusions. 2500 w. Contemporary Rev—Nov., 1897. No. 16524 D.

China.

The Foreign Trade in China in 1896. Editorial comment on the report on the foreign trade of China which issues from the Legation at Pekin, and gives a brief review of the whole of the trade and the conditions on which it depends. 1700 w. Engng—Oct. 22, 1897. No. 16276 A.

Competition.

The Competition of the American Iron Industry. (Der Wettbewerb der Amerikanischen Eisenindustrie.) An address by Herr Schrödter discussing the growth of the American iron production and the invasion of German foreign and home markets. 5000 w. Stahl und Eisen—Nov. 15, 1897. No. 16478 D.

The Failure of Legislation to Enforce Railway Competition. H. T. Newcomb. After reviewing the experience of the U. S. under the Interstate Commerce Law, it is shown that other countries do not consider railway competition the correct method of establishing rates. The true competition is that of actual trade, not transportation. 3000 w. Engineering Magazine—Dec., 1897. No. 16899 B.

The Importance of Supremacy in the Iron Trade. J. Stephen Jeans. Particularly discussing the relations of European countries to each other as competitors, based largely upon the report of the British delegation of the iron trade industry upon labor conditions on the continent. The greatest factor in favor of the continental producer is the lower cost of transport. 4500 w. Engineering Magazine—Dec., 1897. No. 16893 B.

See also Railroad Affairs, Miscellany.

Great Lakes.

The Commerce of the American Great Lakes. Charles E. Wheeler. Read at New York meeting of the Society of Naval Architects and Marine Engineers. The effects of cheap transportation by water and its future possibilities. 2800 w. Ir Age—Nov. 18, 1897. No. 16683.

Japan.

Foreigners in Japan. Remarks on the conditions of life of foreign residents, with summary of the main points of the new treaties and the influence of commerce and industries. 2500 w. Engng—Oct. 29, 1897. No. 16391 A.

Merchant Marine.

See Marine Engineering.

Prices.

Effect of the New Gold upon Prices. Charles A. Conant. Reviews the history of previous great additions, and their supposed effect, discusses the subject, and concludes that throughout the world there exists a capacity for the absorption of the new gold, which will therefore have no perceptible effect on prices. 5000 w. N Am Rev—Nov., 1897. No. 16296 D.

Shipyards.

See Marine Engineering.

Trade Commissions.

Commercial Missions in the Far East. Particulars of the methods and working of the Blackburn Commission to China, as gathered by a representative of the *China Mail* during an interview with F. S. A. Bourne, who represent-

ed the British Government. 2400 w. Engr, Lond—Oct. 29, 1897. No. 16511 A.

Trade-Marks.

Trade-Marks in Their International Relations. Francis Forbes. Reviews what has already been done to bring about international protection of marks, and the importance of the movement. 2000 w. Ir Age—Nov. 18, 1897. No. 16684.

Trade Relations.

Our Commercial Political Relation to England. (Unser Handelspolitisches Verhältniss zu England.) An address before the central industrial association of Germany discussing especially the British colonial-trade policy, and the best methods of promoting German commerce. 4500 w. Stahl und Eisen—Nov. 1, 1897. No. 16-474 D.

CURRENCY AND FINANCE.

Austria-Hungary.

The Present Money Reform of Austria-Hungary. Otto P. Eberhard. Relates the experience of Austria, which twice drove her into bankruptcy, and finally brought about the reform which three years ago established the gold standard by the joint action of Austria and Hungary. 2500 w. Bankers' Mag, N. Y.—Nov., 1897. No. 16579 D.

Bimetallism.

Another Free Silver Fiasco. W. R. Lawson. Discussion of the recent agitation in England and the United States Commission. 5400 w. Bankers' Mag, Lond—Nov., 1897. No. 16-523 A.

The Collapse of Bimetallism. Carl Schurz. Comments on the results of the special commission sent by the United States to Europe. 1300 w. Harper's Wk—Nov. 6, 1897. No. 16316.

The Fiasco of the Silver Commission. The history of the negotiations of the silver commission in London as outlined in a Parliamentary paper which was published in that city October 22, 1897. 7000 w. Eng & Min Jour—Nov. 6, 1897. No. 16387.

The Monetary Chaos. Robert Giffen. A discussion of the recent bimetallic agitation from an English point of view, stating the situation and the difficulties, and the principles which ought to guide. 13500 w. Nineteenth Cent—Nov., 1897. No. 16602 D.

China.

Financial Condition of China. Information from the report of British Consul Jamieson, on the "Revenue and Expenditure of the Chinese Empire," with comments. 1800 w. U. S. Cons Repts—Nov., 1897. No. 16521 D.

Coin.

Copper Cents. Interesting information of the most overworked coin made in the United States mints. 1600 w. Bos Jour of Com—Nov. 13, 1897. No. 16574.

Currency Reform.

A Proposition for Currency Reform. Explains the system suggested by John C. Bullitt, of Philadelphia, for the reform of the United States currency, and thinks the plan has much to commend it. 1400 w. Bradstreet's—Nov. 13, 1897. No. 16634.

Finance.

On the Financial Relations of Great Britain and Ireland. John Lubbock. Discusses the Report of the Financial Relations Commission, and aims to show that Ireland has been justly and even generously treated by Great Britain. 4500 w. Nineteenth Cent—Nov., 1897. No. 16603 D.

Permanent Currency.

Suggestion for a Stable Currency. E. J. Sanford. States the conditions of the United States currency at the present time, and gives suggestions for turning the entire banking business over to the national banks under certain rules and regulations. 1300 w. N Am Rev—Nov., 1897. No. 16299 D.

GOVERNMENT CONTROL.

Interstate Commerce.

The Long- and Short-Haul Clause Again. Comments on the decision rendered by the Supreme Court of the United States in the case of the Interstate Commerce Commission against the Alabama Midland and the Georgia Central Railroad Companies and others, arising out of complaints made by the citizens of Troy, Alabama. 1200 w. Bradstreet's—Nov. 13, 1897. No. 16635.

Municipal Ownership.

See Street and Electric Railways.

LABOR.

Employes.

See Street and Electric Railways.

Engineers' Strike.

One Aspect of the English Engineers' Strike. From the *Newcastle Herald*, England. Gives an account of the routine of life and methods of boarding the men on an old passenger steamer moored in the river near the Yarrow works. 1300 w. Engr, N. Y.—Nov. 1, 1897. No. 1 6339.

Profit-Sharing as a Remedy. Editorial discussion of the situation in England, brought about by this strike, and of Mr. Livesey's suggestion of profit-sharing. 2800 w. Engng—Nov. 5, 1897. No. 16620 A.

The Amalgamated Society and the Strike. Discusses the effect of the strike on English trade, the mistakes of unions, and related matters. 1800 w. Prac Eng—Oct. 29, 1897. No. 16516 A.

The Proposed Armistice. Editorial discussion of the present state of affairs in regard to the engineering strike in England. 2000 w. Engng—Oct. 29, 1897. No. 16390 A.

Great Britain.

See Railroad Affairs, Miscellany.

Labor Handling.

National Differences in Labor-Handling Methods. Hiram S. Maxim. The eastern portion of Europe is compared with the western and

the western with the United States, the progress being from high individual skill and small production to highly improved tools and large production. Personal experiences in various parts of Europe are given. 3000 w. Engineering Magazine—Dec., 1897. No. 16891 B.

The Railway Problem and Labor. Robert P. Porter. Shows that if rates continue to decline, and properties to deteriorate in the United States, a reduction of wages will be absolutely necessary. Also urges an examination of the question and its effect on every class of labor. 2200 w. Ry Mag—Oct., 1897. No. 16605 C,

See also Mining and Metallurgy, Coal and Coke.

Strike Insurance.

Insurance Against Strikes. Editorial on a proposed scheme to indemnify manufacturers and others against loss through oppression from trades unions. 1600 w. Engr, Lond—Nov. 5, 1897. No. 16645 A.

Trade Unions.

The Amalgamated Society of Engineers, in England. History of the society, with details as to its general system of management, with discussion of the probable results of the struggle in which it is at present engaged. Also editorial. 4800 w. Engr, Lond—Oct. 29, 1897. No. 16509 A.

MISCELLANY.

Address.

The Relation of Technology to Mathematics (Die Beziehungen der Technik zur Mathematik). An address delivered by Prof. Stodola, of Zurich, at the International Mathematical Congress, 1897. The growing relation of theoretical computations to practical work is well shown by various examples in recent practice. 4000 w. Zeitschr d Ver Deutscher Ing—Oct. 30, 1897. No. 16407 D.

Education.

Past and Present Tendencies in Engineering Education. Mansfield Merriman. Presidential address at Buffalo, N. Y., meeting, showing the wonderful changes of opinion in regard to technical education, and urging that, general, education is more important than exclusively engineering courses. 4500 w. Pro of Purdue Soc of Civ Engs—1897. No. 16806 D.

Industrial School.

See Electrical Engineering, Miscellany.

Inventions.

Notes on the History of Invention in the 17th and 18th Centuries. (Beitrage zur Geschichte der Erfindungen im Siebenzehnten und Achtzehnten Jahrhundert.) An interesting contribution to the history of early patents in England and on the Continent. Serial. 1st part. 4000 w. Glaser's Annalen—Oct. 15, 1897. No. 16440 D.

Valuation.

See Mechanical Engineering, Miscellany.

Value.

Utility and Cost as Determinants of Value. Carl Stroever. A presentation of the writer's views which are opposed to the Austrian school, as expressed in a paper by Prof. Von. Boehm-Bowerk. 8000 w. An of Am Acad—Nov., 1897. No. 16685 G.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

Bleaching.

The Application of Electrolysis to the Production of Bleaching Material. (Ueber die Anwendung der Electrolyse zur Darstellung von Bleichmitteln.) A description of the electrolytic bleaching method of Dr. Kellner, as applied by Messrs. Siemens & Halske. Two articles. 7000 w. Elektrochemische Zeitschr—Aug.-Sept., 1897. No. 16458 E.

Chemical Theory.

Contributions to the Theory of Electrochemistry. (Beiträge zur Elektrochemischen Theorie.) R. Mewes. Discussing the relation of the vibratory theory of chemical action to the corresponding phenomena of electrochemistry. Two articles. 6000 w. Electrochemische Zeitschr—Sept.-Nov., 1897. No. 16456 E.

Electrolysis.

A Mechanical Theory of Electrolysis Based on Maxwell's Hypothesis. (Mechanische Theorie der Elektrolyse auf Grund der Maxwell'schen Hypothese.) Prof. Weyde. Containing an interesting mechanical analogy to the supposed molecular movements in electrolysis. 2000 w. Elektrotechnische Zeitschr—Nov. 4, 1897. No. 16469 B.

Electrolytic Determination of Nickel and Cobalt in Steel. M. O. Ducru. Translated from *Comptes Rendus*. Discusses methods used. 1000 w. Am Mfr & Ir Wld—Nov. 12, 1897. No. 16625

Experiments to Determine the Electrolytic Separation of Metals by Use of an Electric Meter. (Versuche die bei der Elektrolytischen Trennung von Metallen durch einen Elektricitätszähler zu Messen.) By closely regulating the strength of current various metals can be separated from a combined solution with a close degreee of accuracy. 4000 w. Zeitschr f Elektrochemie—Sept. 20, 1897. No. 16451 B.

The Electrolytic Separation of Nickel from an Aqueous Solution of its Sulphate or Chloride. (Ueber die Elektrolytische Abscheidung des Nickels aus den Wässerigen Lösungen seines Sulfats oder Chlorids.) Dr. F. Foerster. Discussing methods of obtaining a bright deposit of nickel of a greater thickness than has heretofore been practicable. 3500 w. Zeitschr f Elektrochemie—Sept. 20, 1897. No. 16452 B.

Electrolytic Alkali.

Industrial Notes on Electrolytic Alkali. John B. C. Kershaw. Brief discussion of the position and prospects of the three electrolytic soda processes. 800 w. Elect'n—Nov. 5, 1897. No. 16631 A.

The Electrical Equipment of Mathieson Alkali Works. J. R. Haskin. Confined to a description of the electrical machinery of the latest addition to the plants surrounding the great power house of the Niagara Falls Power Company. Ill. 900 w. Elec Wld—Nov. 27, 1897. No. 16847.

Electrolytic Apparatus.

Rhodin's Electrolytic System. Illustrated description of an apparatus for the extraction of metals, soda, potash and other alkaline salts, and also for the electrolytic production of a large number of other chemicals. 1100 w. Elec Rev, Lond—Oct. 29, 1897. No. 16380 A.

Galvanizing.

The Electrolytic Galvanizing of Iron. (La Galvanization Electrolytique du Fer.) A description of Wagner's method of coating iron with zinc by true galvanic action instead of dipping in a metal bath. 2500 w. Moniteur Industriel—Sept. 11, 1897. No. 16492 F.

History.

Electro Chemical Progress. Bertram Blount. Consideration of recent developments noting advances made and the tendency of thought. 2500 w. Elect'n—Nov. 12, 1897. No. 16718 A.

The Progress of Electro-Chemistry and Electro-Metallurgy During the Last Twenty-Five Years. Emile Andreoli. Sketches the progressive movement, and shows the immense amount of work accomplished. 4000 w. Elec Rev, Lond—Nov. 12, 1897. No. 16747 A.

Russia.

Electrolysis and Electro Metallurgy in Russia. (Elektrolyse und Elektrometallurgie in Russland.) Mainly a review of the commercial development of electrochemical industries in Russia since the Moscow exposition of 1882. 2500 w. Elektrochemische Zeitschr—Sept., 1897. No. 16457 B.

LIGHTING.

Advertising.

Electric Advertising. Description, with illustrations, of some of the effects secured by simple means. 1700 w. Dom Engng—Nov., 1897. No. 16704 C.

Arches.

Electric-Light Arches at Columbus, O. Engraving showing the appearance and details of construction, with explanation of how they came to be erected. 700 w. Elec Eng, N. Y.—Nov. 11, 1897. No. 16541.

Arc Lamp.

The Davy Enclosed Arc Lamp. Illustrated description of the lamp and its action. 600 w. Elect'n—Nov. 12, 1897. No. 16717 A.

Arc Lighting.

Twenty-Five Years Progress in Arc Lighting. R. E. Crompton. Historical Review. 3300 w. Elec Rev, Lond—Nov. 12, 1897. No. 16754 A.

Arcs.

Some Experiments on the Alternating-Current Arc. Charles F. Smith. A short description of experiments and appliances used. Ill. 600 w. Elect'n, Lond—Oct. 22, 1897. No. 16282 A.

Bradford Corporation.

Some Features of the Electricity Department of the Bradford Corporation, England. Alfred H. Gibbins. A short résumé of what has been done in Bradford in the adoption of certain beneficial arrangements with customers, such as free supply of lamps, hiring out of lamps and motors, inspection and repair. 1600 w. Elec, Lond—Oct. 29, 1897. No. 16376 A.

Conductors.

Devices for Supporting Large Conductors. S. H. Sharpsteen. Suggestions for wiring. 1200 w. Elec Eng, N. Y.—Nov. 11, 1897. Serial. 1st part. No. 16545.

Congressional Library.

Tests of the Illumination of the Rotunda in the Building for the Library of Congress. Cary T. Hutchinson. Describes the arrangements of the lights and the manner of testing. Ill. 1300 w. Elec Eng, N. Y.—Nov. 4, 1897. No. 16328.

Counter Electromotive Force.

Does the Counter E. M. F. Exist in the Arc? W. R. Bonham and Harold Almert. Records an experiment recently performed which throws some light on this subject. 600 w. Elec Eng, N. Y.—Nov. 11, 1897. No. 16542.

Efficiency.

The Factors Which Determine the Efficiency of the Alternating-Current Arc. William Beckit Burnie. An illustrated account of experimental investigations with results. 4900 w. Elect'n, Lond—Oct. 22, 1897. No. 16281 A.

Generators.

1500-k. w. Generators at the Station of the Allegheny County Light Company. P. H. Thomas. Describes the construction and gives other information. Ill. 2000 w. Elec Wld—Nov. 20, 1897. No. 16674.

Illumination.

European and American Practice. J. McGhie. Impressions very favorable to the electric development in England and France. 2200 w. Jour of Elec—Oct., 1897. No. 16548.

Incandescent Lighting.

Twenty-Five Years Progress in Incandescent Lighting. J. W. Swan. A brief review of the development. 1700 w. Elec Rev, Lond—Nov., 12, 1897. No. 16742 A.

Manchester, England.

Manchester, Eng, Electric Lighting and Traction. A brief and general report of the deputation recently appointed to visit the Continent for the purpose of inspecting Continental stations. 2500 w. Elec Rev, Lond—Oct. 29, 1897. No. 16379 A.

Projection.

Electrical Projection of Election Returns. Illustrated description of some of the arrangements made to display the returns at the recent election in New York. 800 w. Elec Wld—Nov. 13, 1897. No. 16551.

Scotland.

Cumbuslang Electric Lighting. Describes the installation at this small town on the Clyde. Ill. 2300 w. Elec Eng, Lond—Nov. 5, 1897. No. 16662 A.

Theatre.

The New Grand Theatre at Fulham. J. F. Tester. Describes the private electric-lighting installation in detail. 1300 w. Elec, Lond—Oct. 29, 1897. No. 16375 A.

York House.

Electric Lighting at York House. J. F. T. Describes a private electric-light installation in the premises which form the headquarters of the Junior Army and Navy Stores, London. 1400 w. Elec, Lond—Oct. 29, 1897. No. 16373 A.

POWER.

Alternators.

Alternator Design. J Fischer-Hinnen. From the *Elektrotechnische Zeitschrift*. An essay on the calculation of alternating current machinery, with special reference to the drop of pressure in the armature windings. Ill. 1200 w. Elec Eng, Lond—Nov. 5, 1897. Serial. 1st part. No. 16664 A.

A Universal Alternator for Laboratory Purposes. Henry S. Carhart. Illustrated description of the machine with reasons for adopting this design. 700 w. Am Elect'n—Nov., 1897. No. 16537.

Some Notes on the Parallel Running of Alternators. Sidney E. T. Ewing. Remarks on this subject of interest to engineers in charge of alternators connected in parallel. 2000 w. Elec Eng, Lond—Oct. 22, 1897. No. 16280 A.

The Design of Alternating Current Generators with Regard to the Drop in Tension. (Die Vorausberechnung von Wechselstrommaschinen mit Bezug auf den Spannungsabfall.) J. Fischer-Hinnen. With diagrams of windings and tables of data, together with applications to practical examples. 7500 w. Elektrotechnische Zeitschr—Oct. 14, 1897. No. 16466 B.

Armatures.

Investigation of the Loss of Pressure in Armature Windings of Alternate Current Machines. Translated from *Elektrotechnische Zeitschrift*. Illustrated description of method. 900 w. Elec, N Y—Nov. 24, 1897. Serial. 1st part. No. 16837.

Batteries.

Twenty-Five Years' Progress in Secondary Batteries. L. Epstein. Slow but steady progress is shown. 3300 w. Elec Rev, Lond—Nov. 12, 1897. No. 16745 A.

Central Stations.

Twenty-Five Years' Developments in Central Stations. Robert Hammond. The review is limited to works in the United Kingdom. 4500 w. Elec Rev, Lond—Nov. 12, 1897. No. 16761 A.

Charges.

Low Tariffs versus Large Profits Examines the subject of charges for electrical energy, explaining the two opinions which exist and discussing the subject generally. 2400 w. Elec, Lond—Oct. 29, 1897. No. 16374 A.

Conductors.

Safe Carrying Capacity for Electrical Conductors. C. H. Sewall. Read before the Chicago Electrical Assn. Discusses the general physical laws and conditions which bear upon the subject. 3000 w. W Elect'n—Nov. 27, 1897. No. 16886.

Connecting Dynamos.

The Connecting of Dynamos for Simultaneous Operation. Reviews the various methods ig common use. Ill. 2700 w. Am Elect'n—Nov., 1897. No. 16539.

Cost.

See the same title under Mechanical Engineering, Power and Transmission.

Current Generation.

The Comparative Advantages of Steam, Gas, Air and Water-Power in the Generation of Electric Current. Brief discussion of the advantages and disadvantages of each. 1800 w. Elec, Lond—Oct. 29, 1897. No. 16378 A.

Distribution.

The Advantages of Electrical Distribution in Navy Yards. O. G. Dodge. Letter setting forth the advantages to be gained by the distribution of power in the navy yards by electricity from one central point. 1400 w. Elec Wld—Nov. 13, 1897. No. 16552.

The Distribution of Electrical Energy. C. H. Wordingham. Read before the Northern Society of Electrical Engineers, England. The writer favors the use of continuous currents for distribution in cities and towns of considerable size. 3300 w. Elec Eng, Lond—Nov. 12, 1897. Serial. 1st part. No. 16741 A.

The Distribution of Electric Energy in Paris. (La Distribution de l'Energie Electrique à Paris.) A discussion of the report of M. Bos to the Municipal Council of Paris in the matter of the applications of various corporations for franchises for electric power distribution. It is recommended in the report that the work be kept under municipal supervision and regulation. 3000 w. La Revue Technique—Nov. 10, 1897. No. 16431 D.

Drainage Plant.

The Electric Drainage Plant at the Memel Delta. (Die Elektrischen Schöpfwerksanlagen im Memel-Delta.) With plan and detailed account of the application of electric power for the operation of the scoop-wheel pumps for draining 45,000 acres of the delta of the Niemen on the Baltic Sea. 10000 w. Elektrotechnische Zeitschr—Sept. 30, 1897. No. 16464 B.

Dynamos.

Dynamo Troubles and How to Overcome Them. Percy Domville. Read before the Hamilton Assn. C.A.S.E. Hints as to the care of a dynamo and an idea of some of the accidents which are likely to occur, and the best way to repair them. 2800 w. Can Elec News—Nov., 1897. No. 16550.

Electric Locomotive.

See Mining and Metallurgy, Mining.

Electric Plant.

See Mechanical Engineering, Boilers.

Elevators.

Standards of Practice in Electric-Elevator Installation. P. R. Moses. With detailed descriptions of the latest type of the leading builders and a discussion of the essential features of successful design. Electric elevators are claimed to be the safest vehicles known to humanity. 4500 w. Engng Mag—Dec., 1897. No. 16900 B.

Factory.

Electric Power and Lighting Plant of the Mergenthaler Linotype Co., Brooklyn, N. Y. Illustrated detailed description. 2000 w. Elec Eng, N. Y.—Nov. 18, 1897. No. 16676.

Generators.

See Street and Electric Railways.

Haulage.

See the title Towing, under Civil Engineering, Canals, Rivers and Harbors.

History.

Twenty-five Years of Dynamo-Electric Machinery. W. B. Esson. Especially discusses the Gramme and the Von Hefner Alteneck machines, noting also the general development of designs. 2000 w. Elec Rev, Lond—Nov. 12, 1897. No. 16743 A.

Twenty-Five Years Retrospect on Primary Galvanic Batteries. T. E. Gatehouse. Historical review of the progress as recorded in the *Electrical Review* during the time named. 4000 w. Elec Rev, Lond—Nov. 12, 1897. No. 16-762 A.

Magnetic Lifter.

Great Plates Moved by Electricity. From the *Pittsburg (Pa.) Dispatch*. The work of the great magnets at the plate mill of the Illinois Steel Company is described. 1200 w. Bul of Am Ir & St Assn—Nov. 20, 1897. No. 16715.

Marine Machinery.

Electricity on Merchant Vessels. (Die Elektrizität an Bord von Handelsdampfern.) With details of the applications of electricity to lighting, hoisting, transmission of intelligence, &c., as used on modern ocean steamers. Two papers. 7500 w. Zeitschr d Ver Deutscher Ing—Oct. 30, Nov. 6, 1897. No. 16406 G.

Meters.

Meters versus Flat Rates. R. F. Schuchardt. Urging that central stations abandon the system of flat rates and sell their current by meter. 1200 w. Elec Eng, N. Y.—Oct. 28, 1897. No. 16233.

Mine Transmission.

The Electric Power-Transmission at Bleiberg. (Die Elektrische Kraftübertragung in Bleiberg.) The stream Nötschbach furnishes 285 h. p., which is transmitted electrically among four mines for pumping, hoisting aud lighting. Two articles, three plates. 10000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 16, 23, 1897. No. 16485 E.

Motor Car.

The Elieson Electric Motor Car. Illustrated description of the method of construction. 700 w. Elect'n—Nov. 12, 1897. No. 16719 A.

Motors.

Induction-Motor Design. Harris J. Ryan and J. J. Macomber. Analysis of the induction motor. 2500 w. Sib Jour of Engng—Nov., 1897. Serial. 1st part. No. 16865 C.

Theory of Constant-Speed, Direct-Current, Constant-Potential Motors. William Baxter, Jr. Considers the multiplication of formulæ for the calculation of motors a step in the wrong direction. Ill. 2200 w. Elec Wld—Nov. 27, 1897. No. 16846.

Testing Three-Phase Induction Motors—Transformer Connections—Full-Load Currents—Faults and How Located. W. T. Morrison. The subjects named are briefly treated in part first. 1000 w. Elec Eng, N. Y.—Nov. 11, 1897. Serial. 1st part. No. 16544.

Power Plant.

Power Plant on the Yadkin River, North Carolina. Illustrated description of plant being built by the Fries Manufacturing and Power Company, of Salem, N. C. 900 w. Fire & Water—Nov. 27, 1897. No. 16882.

Printing Machinery.

Electrically-Driven Printing and Binding Machinery. A. N. Rathbun. Describes and illustrates the plant of the S. S. McClure Company, publishers of McClure's Magazine. 1600 w. Am Elect'n—Nov., 1897. No. 16535.

Railroads.

See Railroad affairs, New Construction, and Street and Electric Tramways.

Rating.

Notes on Rating Electric-Power Plants upon the Heat-Unit Standard. William S. Aldrich. A second paper on this subject, the first having been read at the Hartford, Conn., meeting (May, 1897). Discusses progress shown in the past four years, &c. 3000 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16821 D.

Resistance.

Permanency of Resistance Coils. W. E. Ayrton. A comparison of results in order to determine the change that may have occurred in the resistance of the four coils used by Prof. Viriamu Jones in 1894. 500 w. Elec Eng, Lond—Nov. 5, 1897. No. 16663 A.

Rheinfelden.

The Great Electrical-Power Plant at Rheinfelden on the Rhine. Illustrated detailed description. 1300 w. Sci Am—Nov. 20, 1897. No. 16691.

Sea Lock.

Electric Plant for Operating and Lighting the New Sea Locks at Ymuiden. (Elecktrische Einrichtung zur Bewegung und Beleuchtung der Neuen Seeschleuse zu Ymuiden, Holland.) The lock gates are operated by winding-cable mechanism driven by electric motors. 1200 w. Glaser's Annalen—Nov. 1, 1897. No. 16444 D.

Transmission.

A Sierran Transmission. George P. Low. Full illustrated description of the plant of the

Blue Lakes Water Company in California, with information of the financial condition and persons interested. 9500 w. Jour of Elec—Oct., 1897. No. 16547.

Electricity in Cotton Mills. W. B. Smith McNally. Describes two plants, working under as nearly identical conditions as possible, one operated by rope transmission, the other by means of motors. 1300 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16827 D.

Swiss Transmission of Power Plants. Wilfrid L. Spence. Notes, principally on polyphase transmission plants, with a comparison between rival systems. 5000 w. Elec Eng, Lond—Nov. 12, 1897. No. 16739 A.

The Mechanicsville Schenectady (N.Y.) Power Transmission. Charles P. Steinmetz. Illustrates and describes some of the electrical features, giving reasons why they were adopted. 1800 w. Elec Wld—Nov. 13, 1897. No. 16555.

Transmission of Power by Two-phase Currents. (Transmission de Force par Courants Biphasés.) An account of the electric-power installation at the linen mills of Gluck & Co., Mulhouse, Alsace, in which very great uniformity of speed under variable load was demanded. A variation within one-fourth of one per cent. was maintained. 2000 w. Le Génie Civil—Oct. 30, 1897. No. 16424 D.

Twenty-Five Years of Transmission of Power by Electricity. Rankin Kennedy. The dynamo had just been designed, the progress is traced and the applications discussed. 2300 w. Elec Rev, Lond—Nov. 12, 1897. No. 16753 A.

TELEGRAPHY AND TELEPHONY.

Cable Capacity.

The Electrostatic Capacity of Long Cables. Walter J. Murphy. Letter to the editor criticising the Muirhead-Gott method, and describing method used by the writer. 800 w. Elect'n—Nov. 5, 1897. No. 16632 A.

Cable Insulation.

Insulator and Cable Testing, with Suggestions for New Apparatus. N. Monroe Hopkins. Describes some methods of insulator and cable testing, with suggestions which may prove of assistance to those who wish to experiment. Ill. 1200 w. Am Elect'n—Nov., 1897. No. 16536.

Earth Currents.

Electric Earth Currents Viewed Astronomically. Arthur E. Cotterell. Suggestions as to the probable cause of the important effects which are demonstrated to be due to these currents. 1800 w. Elec Rev, Lond—Oct. 22, 1897. Serial. 1st part. No. 16253 A.

Electric Measurements.

The Sensitiveness of the Telephone, and its Applicability to Electric Measurements. (Die Empfindlichkeit des Telephons und Seine Verwendung in der Messtechnik.) Devoted to an investigation of the precision which may be obtained by the use of the telephone in connection with a Wheatstone bridge for electric measurements. Two articles. 5000 w. Elektrotechnische Zeitschr—Sept. 3, Oct. 7, 1897. No. 16465 E.

Faults.

Improvements in the Localization of Faults in Submarine Cables by Null-Method Bridge Measurement. C. W. Schaefer. Examines sources of error, explains improved methods, and gives suggestions. 2400 w. Elect'n—Oct. 29, 1897. No. 16519 A.

History.

The Infancy of the Telegraph. From the *Dundee Advertizer*. Gives account of efforts for establishing communication at a distance, dating from the 15th century. 600 w. Elec, Lond—Oct. 29, 1897. No. 16377 A.

Twenty-Five Years of Telegraphic Progress. W. H. Preece. Considers instruments, apparatus, line construction, extent of plant, &c. 2000 w. Elec Rev, Lond—Nov. 12, 1897. No. 16759 A.

Twenty-Five Years' Developments in Telephony. J. E. Kingsbury. A review of the progress from its beginning. 3800 w. Elec Rev, Lond—Nov, 12, 1897. No. 16756 A.

Lighthouse Communication.

Electrical Communication with Lighthouses and Light-Vessels. Fifth and final report of the Royal Commission appointed to inquire what lighthouses and light-vessels it is desirable to connect with the telegraphic system of the United Kingdom by electrical communication. Abstract. 5000 w. Elect'n, Lond—Oct. 22, 1897. No. 16284 A.

Line Connections.

To Solder or Not to Solder. A. E. Dobbs and Charles H. Nohth. Gives an acccunt of test work in joints which resulted in the writers deciding not to solder joints, except where copper and iron are joined. Ill. 2000 w. Elec Eng, N. Y.—Nov. 18, 1897. No. 16677.

Magnetism.

See Mining & Metallurgy, Iron & Steel.

Microphones.

The Law and the Microphone. A résumé of the proceedings leading to the present situation of the suit of the American Bell Telephone Company vs. National Telephone Company. 4200 w. Elec Engng—Nov. 15, 1897. No. 16559.

Military Telegraphy.

Twenty-Five Years' Progresss of Military Telegraphy. R. von Fischer-Treuenfeld. Historical review. 2700 w. Elec Rev, Lond—Nov. 12, 1897. No. 16744 A.

Persia.

Telegraphs and Telephones in Persia. Interesting consular report giving history of these lines. 1500 w. W Elec—Nov. 20, 1897. No. 16772.

Submarine Telegraphs.

The Construction, Laying, and Repairing of Submarine Telegraphs. Charles Bright. Reports steady improvements in materials and details. 3800 w. Elec Rev, Lond—Nov. 12, 1897. No. 16757 A.

Telephone Service.

The Growth of the "Private-Branch Tele-

phone Exchange" Service in New York City—An Interesting Evolution. Explanation of a change that has been made in the past year which is reported as highly satisfactory. Ill. 1500 w. Elec Eng, N. Y—Nov. 25, 1897. No. 16848.

Wireless Telegraphy.

Telegraphy Without Wires. (Die Telegraphie ohne Draht.) A paper by Dr. Müllendorff, discussing the various stages of the development of wireless telegraphy leading up to Marconi's practical application. 3500 w. Glaser's Annalen—Nov. 1, 1897. No. 16443 D.

MISCELLANY.

Accumulator.

A New Electric Accumulator. (Nouvel Accumulateur Electrique.) The Digoine plate is composed of a network of leaden wires, soldered together to form a flat cage, which is stuffed with a paste composed of red lead. 1500 w. Le Génie Civil—Oct. 16, 1897. No. 16421 D.

America and Europe.

American Electrical Engineering in Europe. Robert P. Porter, in the Philadelphia *Inquirer*. Statistics and general information relating to the rapidity with which American electrical engineering is pushing its way. 2000 w. Elec Rev, N. Y.—Nov. 17, 1897. No. 16667.

Argon.

The Behavior of Argon in X-Ray Tubes. H. L. Callendar and N. N. Evans. Read before Section A of the British Assn., at Toronto. Report of investigations. 2500 w. Nature—Oct. 28, 1897. No. 16385 A.

Boston.

Electrical Boston Thirty Years Ago. Thomas A. Edison. An article prepared by Mr. Edison for a newspaper while he was a Western Union night operator in Boston, Mass. It gives a most interesting idea of the concerns making apparatus in Boston at the time, and of their specialties. 1800 w. Elec Eng, N. Y.—Nov. 18, 1897. No. 16678.

Coherer.

I. The History of the Coherer Principle. Oliver Lodge. II. The Practical Applications of the Coherer. A. C. Brown. III. On Compressional Electric or Magnetic Waves. Oliver Heaviside. IV. A Carbon Detector or Receiver for Hertz Waves. Frederick J. Jervis-Smith. A series of articles dealing with the theory and applications of the coherer to wireless telegraphy. 14300 w. Elect'n—Nov. 12, 1897. No. 16720 A.

Conductors.

The Molecular Theory of Conductors. (Molekular Theorie der Stromleiter.) A communication by Dr. Silberstein, relating especially to dielectrics, and poor conducting materials. 1500 w. Elecktrochemische Zeitschr—Oct., 1897. No. 16459 B.

Curve Tracer.

An Electric Curve Tracer. Edward B. Rosa. Illustrated description of apparatus for reducing the labor and increasing the speed of drawing electric curves, for delineating the forms and phases of periodic electric quantities. 2300 w. Elec Wld—Nov. 27, 1897. Serial. 1st part. No. 16845.

Cut Outs.

How Shall Electrical Apparatus Be Protected? Joseph Sachs. States the conditions with which the device must comply, and discusses the two methods—the fusible cut-out and the magnetic circuit-breaker. 3000 w. Am Elect'n—Nov., 1897. No. 16538.

Diffusion Current.

Concerning the Current Generated by Means of Diffusing Gases. (Ueber dem durch Diffundierende Gase Hervorgerufenen Reststrom.) A discussion by Prof. Dannel of some former experiments of Helmholtz, with analytical and experimental investigation. Two articles. 4000 w. Zeitschr f Elektrochemie—Oct. 20, Nov. 5, 1897. No. 16455 E.

Direct Generation.

Electricity Direct from Coal. (Elektricität Direkt aus Kohle.) A general review of the efforts which have been made during the past ten years to accomplish the direct generation of electricity without the intermediate conversion into mechanical energy. Two articles. 9000 w. Zeitschr f Elektrochemie—Sept. 5, 20, 1897. No. 16449 E.

Dynamo Factory.

A Primitive Dynamo Factory and Power Station. An account of work done by the inexperienced. 1700 w. Elec Wld—Nov. 13, 1897. No. 16553.

Diagrams.

Diagram Accounts for Engineering Work. John Jameson. Read before the Institution of Mechanical Engineers, England. Describes a plan of diagram accounts, giving the requisites of the system. 2800 w. Engng—Nov. 12, 1897. No. 16738 A.

Electric Waves.

On the Use of the Interferometer in the Study of Electric Waves. G. F. Hull. Considers the use of the interferometer in the study of light; the analogy between light and electric radiation; apparatus; measurements, &c., with conclusions. 5000 w. Phys Rev—Oct., 1897. No. 16301 D.

Engraving.

Electric Engraving. (Elektrogravure.) A description by Dr. Langbein, of Rieder's new method of producing intaglio and relief modeling, such as medals, dies, etc., by the electric etching of the medal in contact with a reverse plaster model. 1200 w. Zeitschr f Elektrochemie—Sept. 5, 1897. No. 16450 B.

Field Magnets.

The Forms of Field Magnets and Their Influence Upon the Efficiency of Generators and Motors. William Baxter, Jr. A study of this subject and the means of obtaining the best results. Ill. 3000 w. Am Mach—Nov. 11, 1897. No. 16561.

Fuses.

Fuse Wires. R. S. McGowin. Gives the re-

quirements of an efficient fuse, and discusses how to attain them, with further consideration of the subject. 1800 w. Sib Jour of Engng—Oct., 1897. No. 16864 C.

History.

Twenty-Five Years' Developments in Magnetism. Andrew Jamieson. Historical Review. 2000 w. Elec Rev, Lond—Nov. 12, 1897. No. 16760 A.

Twenty-Five Years' Progress in Electro-Therapeutics. W. S. Hedley. Reviews the work of this field and related subjects. 4800 w. Elec Rev, Lond—Nov. 12, 1897. No. 16749 A.

Induction.

The Theory of the Induction Coil. An examination of the mathematical theory of the induction coil as worked out by B. Walter, and of the experiments verifying the results. 1800 w. Elec Rev, Lond—Oct. 22, 1897. Serial. 1st part. No. 16254 A.

Industrial School.

Electricity at the New York State Industrial School. Joseph T. Freeman. Illustrated description of the electrical plant at the school in Rochester, N. Y., which supplies light and power, and furnishes the means by which practical information is given the boys in the care and construction of electrical machinery. 3500 w. Elec Wld—Oct. 30, 1897. No. 16290.

Instruments.

Electrical-Instrument Making During the Period 1872–1897. W. A. Price. The general course of progress is reviewed with brief notice of some important inventions. 2800 w. Elec Rev, Lond—Nov. 12, 1897. No. 16746 A.

Magnetic Shields.

Electromagnetic Phenomena in Connection with the Shielding, Exercised by Iron, of a Magnetic Field from One or More Conductors. James Russell. Gives experiments performed by the writer, with summary of conclusions drawn. 3300 w. Elect'n—Nov. 12, 1897. No. 16716 A.

Measurements.

Absolute Measurements. A. Gray. Traces the system of electrical measurements in its progress, and the benefits from the adoption of the absolute system of units. 2800 w. Elec Rev, Lond—Nov. 12, 1897. No. 16755 A.

Conductivity Measurements with a Direct-Reading Conductivity Bridge. Elmer G. Willyoung and H. P. Harth. Describes a method and apparatus devised by the writers, with a brief statement of its advantages. Ill. 2800 w. Elec Wld—Nov. 13, 1897. No. 16554.

Oils.

Dielectric Strength of Oils. Charles Proteus Steinmetz. Calls attention to an interesting fact relating to their disruptive strength. 500 w. Elec Wld—Nov. 20, 1897. No. 16673.

Phasometer.

The Theory and Application of the Phasometer. (Theorie und Anwendung des Phasometers.) A full analytical investigation of the conditions involved in the production of poly-phase currents and a description of a new instrument for investigating them. 5 articles. 15000 w. Elektrotechnische Zeitschr—Sept. 16, 23, Oct. 7, 21, 28, 1897. No. 16462 H.

Resistance.

The Electrical Resistance of Metals. (Ueber den Elektrischen Widerstand der Metalle.) C. Liebenow. A valuable investigation, including the effects of temperature, and of composition, with curves, tables of constants, and other useful data. Two articles. 12000 w. Zeitschr f Elektrochemie—Oct. 20, Nov. 5, 1897. No. 16454 E.

Series Winding.

The Determination of the Series Windings for a Compound Dynamo. Lawford H. Fry. Sets forth a method which will give approximately the number of ampere windings required. 700 w. Elec Rev, Lond—Oct. 22, 1897. No. 16255 A.

Specialties.

Defects in Electrical Specialty Designing. H. N. Gardner. Calls attention to defects in appliances used in electric-light wiring, and the weak points in many specialties now being made. 1800 w. Elec Eng, N. Y.—Nov. 25, 1897. No. 16849.

Standard Cell.

The Reichsanstalt Type of Cadmium Standard Cell. W. Jaeger. From the *Elektrotechnische Zeitschrift*. Its particular feature is its very small temperature coefficient, enabling it to be used in most cases even for accurate measurements without account of its temperature being taken. 1200 w. Elect'n—Oct. 29, 1897. No. 16518 A.

Note on the Uniformity of the Cadmium Normal Cell. (Notiz über die Herstellung des Cadmium-Normalelements.) Prof. Jaeger. Showing that with the cadmium element a standard of voltage may be obtained and reproduced within an error of one ten-thousandth part. 1500 w. Elektrotechnische Zeitschr—Oct. 21, 1897. No. 16467 B.

Thermo-Electricity.

The Direct Transformation of Heat into Electrical Energy. (Sur la Transformation Directe de la Chaleur en Energie Electrique.) Marcel Deprez. An account of a new method of generating an electric current direct from heat; based on the discovery by M. Guillaume upon the variation in magnetic properties, with heat, of certain alloys of iron and nickel. 1200 w. Comptes Rendus—Oct. 11, 1897. No. 16433 B.

Transformer.

Tesla's High-Potential Transformer. Explains the plan of winding the coils, the connection, and manner of using, stating some of the advantages. 900 w. Elec Eng, N. Y.—Nov. 11, 1897. No. 16543.

Transformers. James Swinburne. Tracing the history during the last quarter of a century, or more correctly, the developments during the last twenty years. 2400 w. Elec Rev, Lond—Nov. 12, 1897. No. 16751 A.

MARINE ENGINEERING.

Bazin Roller Boat.

M. Bazin's Roller Steamship. From *London Graphic*. Illustrated description of the boat and results of experiments made on the trip. 1200 w. Sci Am Sup—Nov. 27, 1897. No. 16802.

Coal Ports.

Coal Ports of Great Britain. An illustrated description of Newport, Monmouthshire. 2800 w. Ir & Coal Trds Rev—Nov. 12, 1897. No. 16786 A.

Contract Trials.

The Contract Trials of the U. S. Gunboats Wheeling and Marietta. F. C. Bieg. Dimensions with description of vessels and equipment, and report of trials. Ill. 3000 w. Jour Am Soc of Nav Engs—Nov., 1897. No. 16594 H.

Engineers.

American Naval Engineers. An examination of the scheme of Ira N. Hollis, as published in the *Atlantic Monthly* for September. 3000 w. Engng—Nov. 12, 1897. No. 16737 A.

Engine Efficiency.

Mechanical Efficiencies of Marine Engines. Bernhard A. Sinn. Explains what is meant by the term, and the ways of finding it. 1200 w. Mech Wld—Nov. 5, 1897. No. 16648 A.

Engines.

See Mechanical Engineering, Engines and Motors.

Experimental Tanks.

Experimental Tanks as an Aid to Marine Engineer and Naval Architect. W. F. Durand. Discussion of their application to experimental investigation, especially in regard to the resistance of ships and the performance of screw propellers. Ill. 3000 w. Marine Engng—Nov., 1897. No. 16531 C.

Floating Dock.

Floating Dock for Saint Paul de Loanda. (Dock Flottant de Saint-Paul-de-Loanda.) A full account of this structure built at Rotterdam for the Portuguese government and successfully towed to Africa; with plate of details and photographs of trials. 1800 w. 1 plate. Le Génie Civil—Oct. 16, 1897 No. 16419 D.

Frigate.

H. M. S. Leander. Investigations made in reference to the history of this vessel. 1800 w. Engr, Lond—Oct. 29, 1897. No. 16510 A.

Gunboat.

A River Gunboat. Illustrated description of the Melik, a twin-screw, shallow-draught gunboat built for the Egyptian government. 1500 w. Engng—Oct. 22, 1897. No. 16273 A.

Light-Draught Gunboats for the Nile Expedition. Description with illustrations of one of the new boats built in England for service above the cataracts. 1500 w. Sci Am—Nov. 20, 1897. No. 16692.

Lighthouses.

Feux-Eclairs or Lightning Flash Lights. John A. Purves. The object of the paper is to show how the system has evolved out of the old and existing order of lights and to point out that the system depends for its explanation and appreciation on common-sense reasoning. Ill. 2500 w. Engng—Oct. 29, 1897. No. 16392 A.

Lightships.

The United States Composite Electric-Light Vessels, Nos. 68 and 69. Illustrated description with dimensions of vessels which are to be stationed on the Atlantic coast of the United States at Fire Island, and the Diamond-Shoal off Cape Hatteras. 2400 w. Marine Engng—Nov., 1897. No. 16532 C.

Merchant Marine.

The American Merchant Marine. Charles H. Cramp. Read at a meeting of the New York Board of Trade and Transportation, Oct. 28, 1897. Presents facts showing the condition of the United States merchant marine, explaining why it is in its present situation, and suggesting the remedy. Gives a survey of English experiences. 4000 w. Sea—Nov. 4, 1897. No. 16338.

Marine Machinery.

See Electrical Engineering, Power.

Naval Architecture.

On the Advances Made in the Mathematical Theory of Naval Architecture During the Existence of the Institution. Edward J. Reed. Read at the International Congress of Naval Architects and Marine Engineers. Interesting historical review of progress. 15000 w. Jour Am Soc of Nav Engs—Nov., 1897. No. 16601 H.

Navies.

The Navies of the United States and Spain—A Comparison. Brief review of the two navies, showing Spain to possess a fleet not to be despised, which would enable her to maintain a fierce and destructive warfare. 1200 w. Sci Am—Nov. 6, 1897. No. 16352.

Police Boat.

Progressive Speed Trials of the Boston Police-Boat Guardian. Extracts from a paper by C. H. Peabody, read at the New York meeting of the Society of Naval Architects and Marine Engineers. Written with the object of inducing shipowners and shipbuilders to make progressive speed trials and present results. 600 w. R R Gaz—Nov. 19, 1897. No. 16694.

Power Transmission.

Auxiliary Engines and Transmission of Power on Naval Vessels. George W. Dickie. A presentation of the subject, with comparisons and conclusions, not aiming to show the superiority of any one system. 7200 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16826 D.

Revenue Cutters.

The Contract Trials of the U. S. Revenue Cutters Manning and McCulloch. C. A. McAllister. Describes these single-screw, composite vessels, and their machinery, with account of trials and other data. Ill. 3800 w. Jour Am Soc of Nav Engs—Nov., 1897. No. 16600 H.

Screw Propellers.

On the Formation of Cavities in Water by Screw Propellers at High Speeds. Sydney W. Barnaby. 2000 w. Jour Am Soc of Nav Engs—Nov., 1897. No. 16597 H.

Shipbuilding.

Shipbuilding as a Productive Industry in Great Britain. James McKechnie. With a discussion of the economic relation of the shipbuilding industry to other branches of trade, followed by illustrated descriptions of the leading British shipyards and their latest productions. 4500 w. Engineering Magazine—Dec., 1897. No. 16892 B.

Shipyards.

The Commercial Value of the Shipyard. Lewis Nixon. Discusses the relation of the shipyard to the arts of peace, showing its effectiveness to be indispensable to national prosperity. Presents the effect in England, and the importance of the subject in America. 5000 w. N Am Rev—Nov., 1897. No. 16295 D.

Society Meeting.

Annual Meeting of the Society of Naval Architects and Marine Engineers. Account of meeting with abstracts of papers. 3000 w. Eng News—Nov. 18, 1897. No. 16711.

Speed Trials.

Analysis of Speed Trials of Ships. William George Walker. Read before the British Assn., Toronto. Illustrates the method of analysis. 800 w. Engr, Lond—Oct. 29, 1897. No. 16515 A.

Some Notes on the Speed Trials and Experience in Commission of Our New Battleships. Philip Hichborn. From a paper read at the New York meeting of Naval Architects and Marine Engineers. The battleships referred to are the American ships Indiana, Massachusetts, Oregon and Iowa. 1300 w. R R Gaz—Nov. 19, 1897. No. 16693.

Steamship.

Newest American-Built Steamship for Hawaiian Islands Trade. Illustrated description of the "Helene" built by the Union Iron Works of San Francisco, Cal. 800 w. Marine Engng—Nov., 1897. No. 16530 C.

Steamboat Lengthening.

Lengthening a Hudson River Steamboat. Illustrated description of the addition of 30 feet to the steamboat New York. 1800 w. Sci Am—Nov. 27, 1897. No. 16799.

Stern Wheeler.

Pittsburg and Cincinnati Packet-Line Stern-Wheel Steamer Queen City. Bert L. Baldwin. Illustrated detailed description. 2500 w. Marine Engng—Nov., 1897. Serial. 1st part. No. 16533 C.

Submarine Work.

The Floating of the Russian Cruiser "Rossia." (Le Relèvement du Croiseur "Rossia.") An account of the manner in which, by very skilful submarine work, divers were successful in floating a 10,000 ton warship, which had run aground in the Neva. 2500 w. Le Génie Civil—Oct. 16, 1897. No. 16420 D.

Torpedo Boats.

The Contract Trial of the U. S. Torpedo Boat Foote. C. N. Offley. Description of vessel and equipment, with account of trial. Ill. 2500 w. Jour Am Soc of Nav Engs—Nov., 1897. No. 16595 H.

The Machinery of Vessels of the Destroyer Type. Brief review of the problem of fast ocean travelling, and of the engines of torpedo-boat destroyers. 2200 w. Mech Wld—Oct. 22, 1897. Serial. 1st part. No. 16246 A.

The U. S. Torpedo Boat Rodgers. W. M. Parks. Description and results of trials made with this boat, which is a sister boat of the Foote. Report of accident during trial. 1000 w. Jour Am Soc of Nav Engs—Nov., 1897. No. 16898 H.

Torpedo-Boat Design and the New Torpedo Boats of the United States Navy. H. G. Gillmor. Read at New York meeting of the Society of Naval Architects and Marine Engineers. Reviews the development of torpedo-boat construction, and discusses the requirements of seagoing and of coast-defence torpedo-boats. Ill. 6200 w. Eng News—Nov. 18, 1897. No. 16708.

Training Vessel.

The New Training Vessel for the Naval Academy. Robert G. Skerrett. Illustrated description of vessel to be built, for which the United States Congress has granted $125,000. 800 w. Harper's Wk—Nov. 27, 1897. No. 16796.

Valve Gear.

The Stevens Valve Gear for Marine Engines. Andrew Fletcher. Two letters on the origin and introduction of this form of valve gear, with drawings. 2000 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16825 D.

Warships.

The British Mediterranean Fleet at Trieste. (Die Englische Mittelmeerflotte in Triest.) An interesting description of the technical points of the British warships in the harbor of Trieste, from an Austrian point of view. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 15, 1897. No. 16408 B.

Two New German Battle Ships. (Zwei Neue Deutsche Panzerschiffe.) Illustrated description of the launch of the battleship Friedrich der Grosse, at Wilhelmshaven, together with an account of the armored cruiser Fürst Bismarck. 2500 w. Stahl und Eisen—Oct. 15, 1897. No. 16472 D.

Water-Tube Boilers.

The Status of the Water-Tube Boiler in the American Marine. W. M. McFarland. With comparative description of the leading types now in approved use, and a discussion of the policy

of the United States Navy. The delay in introducing water-tube boilers was due to prudence in making innovations while the new navy was being created; not to ignorance or lack of appreciation. 5000 w. Engineering Magazine—Dec., 1897. No. 16895 B.

Use of Water-Tube Boilers in the Mercantile Marine. Albert Edward Seaton. Discusses the advantages, enduring power, cost, design, &c., and gives tabulated statements, particulars of the different kinds of boilers, their weights, &c. 3400 w. Jour Am Soc of Nav Engs—Nov., 1897. No. 16596 H.

Water-Tube Boilers. Fred J. Rowan. Abstract of a paper read before the Institution of Engineers and Shipbuilders in Scotland, on Oct. 26, 1897. Calls attention to some historical points connected with water-tube boilers, gives a chronological classification of the designs and discusses circulation, heating surface and combustion. 4000 w. Eng's Gaz—Nov., 1897. No. 16337 A.

Yacht.

Steam Yacht for the English Ambassador at Constantinople. Illustrated description of this vessel built by the Thames Ironworks Company. 500 w. Engr, Lond—Nov. 12, 1897. No. 16731 A.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

Bagasse Furnace.

Furnace for Burning Green Bagasse. (Four à Bruler la Bagasse Verte.) A description of the furnaces used in the sugar plantations of the island Reunion, for burning the crushed cane for generating steam. 1800 w. Le Génie Civil—Nov. 6, 1897. No. 16425 D.

Boiler Rules.

Lloyd's Register New Boiler Rules. A discussion of a recent concession made by Lloyd's Register and its appreciation by marine engine builders, with other changes of rules. 2000 w. Engr, Lond—Nov 5, 1897. No. 16642 A.

Boiler Setting.

A Boiler Setting. G. W. Bissell. Method for supporting a horizontal return-tubular boiler is described. Ill. 250 w. Trans Am Soc of Mech Engs—December, 1897. No. 16829.

The Setting of Horizontal Tubular Boilers. The paper is the result of conversations with designers of boilers, with masons making a specialty of boiler settings, and with operating engineers and firemen, together with observation. Ill. 4000 w. Power—Nov., 1897. No. 16289

Crown Bars.

Crown Bars for Locomotive Boilers. From *The Locomotive*. Deals with the proportion and arrangement of crown bars in locomotive boilers, giving some of the principles that have been found satisfactory in practice. Ill. 2800 w. Prac Eng—Nov. 12, 1897. No. 16774 A.

De Laval Boiler.

The De Laval Steam Boiler. Illustrated description. K. Sosnowski, in *La Nature*. The particular characteristics are high pressure and automatic operation and regulation. 1200 w. Sci Am Sup—Nov. 27, 1897. No. 16803.

Electric Plant.

The Steam-Boiler Question in Electric-Power Plants. (Die Kesselfrage der Elektricitätswerke.) A discussion of various types of steam boilers with regard to their applicability to electric-power plants. 7500 w. Elektrotechnische Zeitschr—Sept. 30, 1897. No. 16463 B.

Fire Engine.

A New Fire-Engine Boiler. Illustrated description of a new departure in the construction of this class of fire apparatus, the invention of Charles H. Fox, of Cincinnati. 1500 w. Fire & Water—Nov. 27, 1897. No. 16883.

Flue Swaging.

Pneumatic Flue-Swaging Machine—Pennsylvania Railroad. Illustrated description of the machine and its operation. 900 w. Ry Mas Mech—Nov., 1897. No. 16343.

Grate.

The "Persian Sword" Grate. (La Grille à Lames de Persiennes.) The "Persian Sword" grate obtains its name from the shape which is given to the air and gas jets by the shape of the openings between the bars; a thorough mingling of the burning gases is obtained. 1200 w. La Revue Technique—Oct. 25, 1897. No. 16427 D.

History.

Twenty-five Years Progress in Boiler Making. W. H. Booth. The progress has been almost wholly in workmanship rather than in principles. 3000 w. Elec Rev, Lond—Nov. 12, 1897. No. 16750 A.

Repairs.

How to Make Heavy Repairs on the Locomotive Boiler. Henry J. Raps. Suggestions for the inspection and repair of boilers. Ill 2500 w. Loc Engng—Nov., 1897. No. 16319 C.

Scale.

Soda Ash as a Boiler Purge. Considers this the cheapest and least objectionable of the chemical compounds used for purification, and explains its action and how it should be used. 1000 w. Ry Mas Mech—Nov., 1897. No. 16342.

Smoke.

A Scale for Determining the Density of Smoke. Describes the system invented by Ringelmann, of Paris, used in Europe in connection with tests of steam boilers and of smoke preventing appliances, with cards required for using the system. 600 w. Eng News—Nov. 11, 1897. No. 16568.

Standard Trials.

Draft of the Report of the Committee on the

Revision of the Society Code of 1885, Relative to a Standard Method of Conducting Steam-Boiler Trials. 16000 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16835 D.

Tests.

Boiler Tests: Classification of Data and Plotted Results. William Wallace Christie. A large collection of tests have been tabulated and the results plotted in diagrams. Tables. Trans Am Soc of Mech Engs—Dec., 1897. No. 16831 D.

Some Boiler Tests at Drummond Colliery. Charles Fergie. The boilers tested were two Stirlings and one Heine, having been in use three and five years, respectively. 1200 w. Can Min Rev—Oct., 1897. No. 16315 B.

Water Tube Boilers.

See Marine Engineering.

COMPRESSED AIR.

Air.

Air Talk. Irving A. Taylor. Discusses the De Bausset air ship and also liquefied air, showing that the first is not practical, and the second very costly. 1500 w. Elec Eng, N. Y.—Oct. 28, 1897. No. 16232.

Air Motors.

Experience with Hoadley-Knight Air-Motor Cars in Washington, D. C. Reports, giving particulars of tests made in the Eckington & Soldiers' Home Railway, generally favorable to the system. 2800 w. Eng News—Nov. 4, 1897. No. 16365.

Compressor.

Corliss-Valved Air Compressor. Describes a compressor patented by Ferdinand Strnad, which compresses the air in one operation to five atmospheres above the atmosphere, with only one air cylinder. From a communication by Herr Kaufhold, of Düsseldorf, to *Glückauf*. Ill. 2700 w. Prac Eng—Oct. 22, 1897. No. 16258 A.

Efficiency of a Four-Stage Air Compressor Delivering Air to a Storage Reservoir. The paper is supplementary to records published in the issue of Oct. 7, giving the total efficiency of the Ingersoll-Sergeant apparatus, and the results derived from it. 1600 w. Eng News—Nov. 4, 1897. No. 16367.

Delaware Breakwater.

The Use of Compressed Air in Building the Delaware Breakwater. C. Weber. Illustrated description. 1400 w. Compressed Air—Nov., 1897. No. 16874.

Explosions.

Explosions of Air Compressors. (Explosionen an Luftkompressoren.) F. Strnad. With details of explosions in various parts of Europe, and a discussion of the causes and remedies. In every case an explosive mixture of air and vapor of oil was ignited by the heat due to the pressure. 3500 w. Glückauf—Oct. 9, 1897. No. 16480 B.

Jerome Park, N. Y.

Abstract of Thesis Test of Compressed-Air Power Plant at Jerome Park, N. Y. George W. Vreeland and Charles M. Younglove. The purpose of the test was to determine the various efficiencies of a central power plant and point out any line of improvement that may be necessary. 1500 w. Compressed Air—Nov., 1897. No. 16873.

Propulsion.

Notes on Propulsion by Compressed Air. (Mittheilungen über Pressluftbetrieb.) A paper, chiefly historical, read before the German Society of Railway Engineers by Herr Henning. Comparisons of cost between propulsion by compressed air and by electricity are given. 4500 w. Glaser's Annalen—Oct. 15, 1897. No. 16438 D.

ENGINES AND MOTORS.

Air Motors.

See Compressed Air.

Alcohol Motors.

Investigations upon Alcohol Motors. (Recherches sur les Moteurs à Alcool.) Max Ringelmann. Showing that more than double the quantity of alcohol is required than of petroleum, for the same power developed, and that with the present prices of alcohol and petroleum the former is commercially impracticable. 1500 w. Comptes Rendus—Oct. 18, 1897. No. 16434 B.

Blowing Engine.

An Improved Blowing Engine. (Eine Neuerung im Gebläsebau.) Illustrated description of the improved blast furnace compound blowing engine with "ring" valves for the air cylinder, as built for the Vajdahunyad Steel and Iron Works in Hungary. Details of working parts are given. 6000 w. Stahl und Eisen—Nov. 15, 1897. No. 16477 D.

Compound Beam Blowing Engine at the Pribram Silver and Lead Works. (Die Balancier-Compound Gebläsemachine bei der Silber- und Bleihütte in Pribram.) A description of the new blowing engine at Pribram, Bohemia, with plate of drawings, indicator diagrams and account of test. 1 plate. 7000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 5, 1897. No. 16412 B.

Breakdowns.

Engine Breakdowns. Extracts from the annual report of the chief engineer of the Engine, Boiler, and Employers' Liability Insurance Co., Limited. Mr. Michael Longridge; with editorial. Ill. 3300 w. Prac Eng—Oct. 22, 1897. No. 16257 A.

Condenser.

The Balcke Tower Condenser. (Kaminkühler Anlage, System Balcke.) Illustrated description of a surface condenser for 2000 h. p. on the Balcke system, with cooling tower for repeated use of condensing water, as shown at the Leipzig exposition. 2000 w. 1 plate. Glaser's Annalen—Oct. 15, 1897. No. 16441 D.

Economizers.

Economizers. Henry G. Brinckerhoff. Discusses their proper construction and uses. Paper read at the meeting of the New England Cotton Manufacturers' Assn., at Philadelphia. 1200 w. Bos Jour of Com—Oct. 30, 1897. No. 16242.

Economy.

Clearance and Compression. F. F. Hemenway. The influence which they extend upon the economy of a steam engine is explained. 2000 w. Mach, N. Y.—Nov., 1897. No. 16527.

Efficiencies.

Multiple-Cylinder Steam Engines. Effects of Variation of Proportions and Variable Loads. Robert H. Thurston and Louis L. Brinsmade. Results of experimental investigation of the relative efficiencies of different engines, under stated conditions. 9000 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16830 D.

Engine Efficiency.

See Marine Engineering.

Engine Test.

An Efficient Steam Plant. An interesting test made by George H. Barrus, at the Grosvenordale Mills, in Connecticut, to determine whether the engine fulfilled the guarantee of its builders, and including a test of the boilers and economizers. 2500 w. Eng Rec—Nov. 20, 1897. No. 16728.

Exhibition.

Boilers and Motors at the Saxon-Thuringian Exhibition at Leipzig, 1897. (Dampfkesseln und Motoren auf der Sächsisch-Thuringischen Gewerbeausstellung zu Leipzig, 1897.) With plans of engine and boiler house, and description of general arrangement, including condensers, feed pumps, and coal-handling plant. 5000 w. Zeitschr d Ver Deutscher Ing—Oct. 2, 1897. Serial. 1st part. No. 16401 D.

Gas Engine.

A New Two-Cycle Gas and Kerosene Engine. Illustrated description of two recent designs, known as Mietz and Weiss gas and oil engines, which bid fair to rival the four-cycle type. 1300 w. Eng News—Nov. 25, 1897. No. 16839.

Gasoline Motor.

The Patton Gasoline-Electric Motor for Street Railways. Describes a self-contained motor car, driven by electricity which is generated by a gasoline engine and electric dynamo on the car. 600 w. Eng News—Nov. 11, 1897. No. 16571.

Governors.

The Thunderbolt Governor. Illustrated description of a most ingenious system of governing. 1100 w. Elec Rev, Lond—Oct. 29, 1897. No. 16381 A.

High-Speed.

High-Speed Self-Lubricating Steam Engines. Alfred Morcom. Read before the Institution of Mechanical Engineers (England). An account of the part taken in their development by the firm of Messrs. G. E. Belliss and Co. and a comparison of their engines with other makes. 5500 w. Jour Am Soc of Nav Engs—Nov., 1897. No. 16599 H.

History.

The Steam Engine. J. S. Raworth. A summary of the last twenty-five years. 2800 w. Elec Rev, Lond—Nov. 12, 1897. No. 16748 A.

Inertia.

Analysis of the Inertia Forces of the Moving Parts of an Engine. John H. MacAlpine. The object of this investigation was to deduce, by harmonic analysis, simple and useful expressions for some of the periodic functions connected with the ordinary connecting-rod engine. They are published now because of their importance in explaining the occurrence in steamships of vibrations of shorter period than that of the revolution of the engine. 3500 w. Engng—Oct. 22, 1897. Serial. 1st part. No. 16278 A.

Motors.

See Electrical Engineering, Power.

Pumping Engine.

See Municipal Engineering, Water Supply.

Rotary Engine.

The Almond Engine. Illustrates and describes a novelty in a rotary engine, which, it claims, is free from all the standard objections to engines of this type. 700 w. Am Mach—Nov. 4, 1897. No. 16347.

Turbines.

The De Laval High-Pressure Steam Turbines at the Stockholm Exhibition. Illustrated description of the high-pressure steam turbine and boiler plant which furnished electric light for the entire exhibition. 1000 w. Elec Eng, N. Y.—Nov. 11, 1897. No. 16540.

Valve Gear.

See Marine Engineering.

POWER AND TRANSMISSION.

Cost.

The Comparative Cost of Steam and Electric Power. Irving A. Taylor. Discussion of how to supply and distribute power with the best economy and convenience. 2000 w. Elec Eng, N. Y.—Nov. 25, 1897. Serial. 1st part. No. 16852.

The Cost of the Generation of Power. (Kosten der Krafterzeugung.) Chr. Eberle. A very full investigation into the relative cost of steam and gas motors as sources of power. Computations are given for units from 200 to 1000 h. p. A valuable paper. 8000 w. Zeitschr f Elektrochemie—Oct. 5, 1897. No. 16453 B.

Elevators.

A Fireproof Grain Elevator. Description of an interesting structure in Buffalo, N. Y. Ill. 1800 w. Eng Rec—Nov. 27, 1897. No. 16879.

Electric or Hydraulic Elevators in Toronto? Abstract of report of E. H. Keating regarding the relative merits of the two systems in order to determine which shall be installed in the new municipal building. The only point where a difference can be considered is in repairs and maintenance and running expenses, and these cannot be determined from facts known. 3000 w. Eng Rec—Nov. 27, 1897. No. 16880.

Modern High-Speed Elevators. Charles E. Emery. Abstract from lecture delivered before students of Sibley College. Reviews the various appliances for lifting, and explains the

principles of the modern high-speed elevator. 3000 w. Sib Jour of Engng—Nov., 1897. No. 16866 C.

See also Electrical Engineering, Power.

Fly-Wheels.

Fly-Wheel Accident at Providence, R. I. An account of the accident, on Sept. 22, at the factory of the Providence Rubber-Shoe Company. Ill. 1800 w. Power—Nov., 1897. No. 16288.

Gas Power.

A Modern Gas Power-Plant. Horace Allen. The gas generator described is of 300 h. p. capacity, and works on the Thwaite patent continuous cycle. Report of tests is given. 1300 w. Engr, Lond—Oct. 29, 1897. No. 16512 A.

Gears.

A Strength of Gear Chart. John B. Mayo. Chart with explanation. 1500 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16832 D.

Gearing.

Unit System of Gearing at the Tennessee Exposition. S. Groves. Describes the special form of gearing employed in the operating mechanism of the see-saw, designed by A. J. Dyer. Ill. 1500 w. Ir Trd Rev—Oct. 28, 1897. No. 16235.

Haulage.

Heckel's Arrangement of Endless-Rope Haulage. M. J. Kersten. From a communication to the Brussels section of the Assn. des Ingénieurs de Liège. Illustrated description of method by which it is claimed that a saving of 10 centimes per ton-kilometre may be effected. 1800 w. Col Guard—Nov. 5, 1897. No. 16650 A.

Mechanical Haulage by Endless Cable. J. Kerston. Communicated to the Assn. des Ingénieurs Sortis de l'Ecole de Liège, and translated from *Revue Universelle des Mines, de la Métallurgie, etc.* Describes a system of mechanical haulage equally suitable for surface requirements or underground purposes. Ill. 1700 w. Ind & Ir—Oct. 22, 1897. No. 16256 A.

The Development of Electric Cableways. Richard Lamb. Describes its application to logging in swamps, canal practice, quarry purposes, &c. Ill. 2500 w. Elec Eng, N. Y.—Nov. 4, 1897. No. 16330.

Power Transmission.

See Marine Engineering.

Printing Machinery.

See Electrical Engineering, Power.

Rope Driving.

A Problem in Continuous Rope Driving. Spencer Miller. Calls attention to the perplexing problems which occur in driving with ropes, showing that with the continuous-rope plan of driving a large increase of power transmitted is obtained. Ill. 4000 w. Pro Am Soc of Civ Engs—Nov., 1897. No. 16862 F.

Steam Power.

Reduction in Cost of Steam Power from 1870 to 1897. F. W. Dean. Presents the economies of this period and the actual cost. 4000 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16824 D.

Transmission.

See Electrical Engineering, Power.

Wave Motor.

The Fletcher Wave Motor. An account of the experimental test recently made at Dover, England, describing the plant and the results of test. Ill. 1600 w. Elec Eng, N. Y.—Nov. 25, 1897. No. 16851.

The Utilization of Wave Power. Describes the working of the wave motors invented by B. Morley Fletcher. Ill. 2500 w. Ind & Ir—Oct. 29 1897. No. 16383 A.

SHOP AND FOUNDRY.

Bearings.

Roller Bearings and Their Applications. Thomas W. How. Read before the Manchester Assn. of Engineers. Discusses the advantages, the requirements and details of construction, and results already obtained. Ill. 2000 w. Prac Eng—Nov. 5, 1897. Serial. 1st part. No. 16666 A.

Bicycle Factory.

A Trip Through a Large Bicycle Factory. Illustrates the design and manufacture of bicycles as carried out at the factory of the Eclipse Bicycle Company, of Elmira, N. Y. 2000 w. Sci Am—Nov. 6, 1897. No. 16353.

Casting.

The Casting of Art Bronze. From *La Nature.* Describes processes and gives interesting information. Ill. 1000 w. Sci Am—Nov. 6, 1897. No. 16354.

The Use of the Riser in Casting. Showing the action of risers for feeding, for relieving the mold of dirty metal, and for indicating the filling of the mold. 1800 w. Mech Wld—Nov. 5, 1897. No. 16647 A.

Cost-Keeping.

Cost-Keeping Methods in Machine Shop and Foundry. Henry Roland. Particularly reviewing methods of checking piece production in order to prevent waste or theft. Details of methods of leading shops are given and examples of the revelations of the application of proper checking methods. 4000 w. Engineering Magazine—Dec., 1897. No. 16898 B.

Cylinder-Heads.

Experiments on the Strains and Stresses on Flat Cylinder-Heads (Untersuchungen über die Formänderungen und die Anstrengung Flacher Boden.) C. Bach. A very thorough series of tests, the deformations being carefully measured for various pressures. Both cast and wrought iron heads, 28 in. diameter, were tested. 3 articles, 2 plates. 20000 w. Zeitscher d ver Deutscher Ing—Oct. 9, 16, 23, 1897. No. 16402 H.

Cylinders.

Method of Boring Large Cylinders in a 72-inch Lathe. Alfred Dunn. A brief illustrated description of the methods used for boring and facing a 64″x10′ 6″ cylinder at one setting. 400 w. Mach, N. Y.—Nov., 1897. No. 16529.

Emery Wheels.

The Emery Wheel and Its Manufacture. Illustrated description of the plant of the Sterling Emery-Wheel Mfg. Company of Tiffin, Ohio, with interesting information about this abrasive. 1300 w. Ir Age—Nov. 4, 1897. No. 16326

Grading.

The Grading of Cast Iron by its Composition. (Die Bewerthung des Roheisens auf Grund seines Verhaltens beim Gattiren mit Brucheisen.) Dr. Wüst. An important paper, showing that irons may be graded satisfactorily by their chemical composition and that test results may be repeated by proper selection of pig and proportion of scrap; with large table of actual examples. 5000 w. Stahl und Eisen—Oct. 15, 1897. No. 16473 D.

Iron Melting.

The Melting of Iron in the Reverberatory Furnace and the Cupola. E. H. Putnam. A discussion of reverberatory-furnace construction, the quality of iron to be used, chilled castings, cupola management for chilled work, &c. 3000 w. Ir Trd Rev—Oct. 28, 1897. No. 16236.

Metal Working.

Experimental Study of Shearing and Punching Metals. (Etude Expérimentale du Cisaillement el du Poinçonnage des Métaux.) M. Frémont. A very full discussion of the work required in punching and shearing, with diagrams, photographs and sections. An important and valuable paper. 30000 w. Bulletin de la Société d'Encour—September, 1897. No. 16437 G.

Mixtures.

Concerning Mixtures of Cast Iron and Steel. (Du Mélange de la Fonte el de l'Acier.) M. J. Vinsonneau. Giving the results of tests of cast iron to which steel has been added during the melting. A marked increase in strength is obtained. Not more than 15 per cent. of steel should be added. 2000 w. Moniteur Industriel —Oct. 23, 1897. No. 16495 F.

Molding.

Machine Molding Without Stripping Plates. E. H. Mumford. Describes machine and its operation. 1600 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16816 D.

Plaster Casts and Other Methods of Molding Shell Forms. John C. Knoeppel. Read at Chicago meeting of the Western Foundrymen's Assn. Describes the making of the casts and their use, the taking of block patterns by stripping, &c. 2300 w. Ir Age—Nov. 25, 1897. No. 16860.

Views on Molding Sand. Interesting discussion by Western Foundrymen at the meeting in Cincinnati, of the paper read by D. H. Truesdale. 5000 w. Ir Trd Rev—Nov. 4, 1897. No. 16360.

Pig Iron.

The Valuation of Pig Iron in Foundry Practice. Dr. Wüst. Read at the meeting of the German Foundrymen's Assn. at Goslar, Prussia. Condensed translation. Showing that the value depends on the chemical composition. 2500 w. Am Mfr & Ir Wld—Nov. 12, 1897. No. 16624.

Railroad Shops.

See Railroad Affairs, Terminals & Yards.

Screw Die.

A Screw Die for the Turret Lathe. James Hartness. Description of a screw-cutting die, possessing novel features, and mention of other means now employed for the same purpose. Ill. 1300 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16823 D.

Shafts.

Relative Proportions of Solid Shafts, Hubs, Sleeves, and Hollow Shafts. Henry Hess. Gives diagram of solid- and hollow-shaft, hub and sleeve relations, with directions for use 2000 w. Am Mach—Nov. 18, 1897. No. 16681.

Shop Arrangement.

A Model Saxon Shop. Illustrated description of the shops of J. E. Reinecker, Goblenz-Chemnitz (Saxony). 1200 w. Mach, N. Y.—Nov., 1897. No. 16528.

A Modern Machine Shop. (Eine Moderne Maschinenbauwerkstätte.) Prof. Theobald Demuth. An illustrated account of the new shop of Kolben & Co. at Prag-Visocan. Nearly all the machine tools are driven by independent motors; electric cranes are used, and all the arrangements are of the most recent types. 3500 w. Zeitschr d ver Deutscher Ing—Oct. 23, 1897. No. 16404 D.

An English Engineering Shop and Some of Its Products. F. J. M. Describes the shop of Joshua Buckton & Co. of Leeds, and the work done there, giving illustrations of machines. 2700 w. Am Mach—Nov. 4, 1897. No. 16344.

Shop Organization.

How Can Shop Organization Be Made More Effective? L. L. Smith. Describes the present organization of a locomotive shop, and discusses economies. Abstract of paper read before the Western Railway Club. 2000 w. Am Eng & R R Jour—Nov., 1897. No. 16241 C.

Sprocket Wheels.

Sprocket-Wheel Finishing Machine. Illustrated description of a machine designed for boring, tapping, facing, and forming sprocket wheels for bicycles, but adapted to other work of like nature. 600 w. Am Mach—Nov. 4, 1897. No. 16346.

Standards.

Standard Fits in the Machine Shop. Arthur A. Fuller. Explains the peculiar adaptation of the limit system in this field, and reports cases of its application. Ill. 2700 w. Mach, N. Y., —Nov., 1897. No. 16526.

Stay Bolts.

A Stay-Bolt-Threading Device. James Hartness. Describes a means for threading stay bolts. Ill. 400 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16818 D.

Test Bars.

Test Bars in the Foundry. R. Moldenke. Read at meeting of the Pittsburgh Foundrymen's Assn. Urging the adoption of standard methods for testing the work. 1400 w. Ir Age —Nov. 25, 1897. No. 16861.

Tools.

Riveting Tools. A. H. Cleaves. Describes tools used and plan of work in riveting a number of thin brass pieces. Ill. 700 w. Am Mach—Nov. 4, 1897. No. 16345.

Special Tools in the Missouri Pacific Shops. Illustrated description of molds for piston-rod packing, chuck for screwing in stay bolts, equalizer clamp, pneumatic dolly bar, and flue expander. 800 w. R R Gaz—Nov. 5, 1897. No. 16370.

Turning.

Device for Turning Slender Metal Articles. Illustrated description of a machine invented by J. D. Mattison. 700 w. Am Mach—Nov. 18, 1897. No. 16680.

Venting.

The Venting Tool. Thomas F. Kennedy. Condemns the usual practice in foundries and the means used for venting; describes how to make a small vent wire, discussing handles and large vent wires. 2500 w. Metal Work—Nov. 6, 1897. No. 16336.

Wrought Castings.

Mitis Founding. K. K. Gives a general idea of the process of making castings from wrought iron. Ill. 2000 w. Am Mach—Nov. 25, 1897. No. 16838.

MISCELLANY.

Automobile.

Road Motors in France. An account of the efforts of the Automobile Club of France to initiate a new class of heavy-weight vehicles, for carrying passengers and baggage. Ill. 1600 w. Engng—Nov. 5, 1897. No. 16618 A.

Bicycles.

Machinery and Tools for Bicycle Construction. (Maschinen und Geräte zur Herstellung von Fahrrädern.) With numerous illustrations of special devices for bicycle manufacturing and assembling, mostly from American sources. Serial. 1st part. 4500 w. Zeitschr d Ver Deutscher Ing—Oct. 2, 1897. No. 16400 D.

Patents and the Bicycle. E. Ralph Estep. On the worthlessness of many patented appliances. 1600 w. Ir Age—Nov. 18, 1897. No. 16682.

Some Points in Cycle Construction. F. J. Osmond. From a paper read before the Institution of Mechanical Engineers, England. Considers friction and rigidity in their relation to the efficiency, and discusses points affecting these. 3300 w. Am Mach—Nov. 18, 1897. No. 16679.

Bicycle-Tires.

Some Types of English Bicycle-Tires. Brief illustrated description of various makes. 1500 w. Ind Rub Wld—Nov. 10, 1897. No. 16671 D.

Computing.

The Comptometer. Fred Morley. Describes and explains the method of operating a practical calculating machine. Ill. 2000 w. Pro of Purdue Soc of Civ Engs—1897. No. 16808 D.

Corrosion.

Internal Corrosion of Wire Ropes. T. G. Lees. Extract from paper read at joint meeting of engineers at Sheffield, Eng., with short discussion. Favors galvanized wire ropes. 2000 w. Col Guard—Oct. 29, 1897. No. 16505 A.

Grain Handling.

Handling the Grain Crop at the Port of New York. Interesting description of the facilities for transporting and handling the immense grain crops of the western states. Ill. 2800 w. Sci Am—Nov. 20, 1897. No. 16690.

Mechanical Composing.

The Lanston "Monotype" Composing and Type-Casting Machine. Illustrated detailed description. 2600 w. Ind & Ir—Nov. 12, 1897. No. 16778 A.

Mechanical Designs.

Idiosyncrasy in Mechanical Engineering. Editorial discussion calling attention to the fact that peculiarities of design are due to individual or national idiosyncrasies. 2200 w. Engr, Lond—Nov. 5, 1897. No. 16646 A.

Paper.

Old Paper. (Alte Papier.) W. Herzberg. An account of investigations made by the chief of the paper testing department of the Charlottenburg laboratory, showing that paper of former times was inferior to that now made. 8000 w. Mitt a d Kgl Tech Versuchsanstalt—Part II, 1897. No. 16447 F.

Refrigerating.

Ammonia Refrigerating Machine. Illustrated description of the invention of B. Lebrun, of Nimy, Belgium, its special feature being the use of two compression cylinders, each opening into a framing filled with oil, so arranged that, if there is leakage, it will be oil and not ammonia. 900 w. Engng—Oct. 22, 1897. No. 16274 A.

Resistance Computations.

Prismatic Moments Considered as Surface Moments of the Second Order in Computations of Resistance. (Die Säulenmomente als Darstellung der Flächenmomente Zweiter Ordnuug in der Festigkeitslehre.) Prof. R. Land. A mathematical discussion simplifying computations involving the moment of inertia in mechanical and statical problems. 5000 w. Zeitschr d Ver Deutscher Ing—Oct. 30, 1897. No. 16405 D.

Strains.

The Computation of Strains in Coal and Grain Bins. A number of letters presenting many diverging views, called out by an article printed in this paper, Sept. 23, 1897, with comments. 4800 w. Eng News—Nov. 4, 1897. No. 16366.

Telescope.

The 40-inch Telescope of the Yerkes Observatory. William E. Reed. Illustrated detailed description, with interesting information. 6500 w. Jour Assn of Engng Socs—Oct., 1897. No. 16791 C.

Testing.

New Method of Testing Metals. (Nouvelle Méthode d'Essai des Métaux.) M. Fremont.

An improved bending test, the ends of the specimen being supported on roller bearings. The data are obtained by measuring the deformations of lines upon the surface of the test piece. 1500 w. Comptes Rendus—Oct. 4, 1897. No. 16436 B.

The Influence of Method of Testing Upon the Results of Bending Tests at Low Temperatures. (Einfluss des Prüfungsverfahrens auf das Ergebriss der Biegeproben bei Niederen Wärmegraden.) Prof. Rudeloff. A graphical and analytical discussion of the results which are secured by the employment of various methods of testing at low temperatures, on various grades of steel. 16000 w. 1 plate. Mitt a d Kgl Tech Versuchsanstalt—Part II., 1897. No. 16446 F.

Testing Machine.

A Photographic Impact Testing Machine for Measuring the Varying Intensity of an Impulsive Force. B. W. Dunn. Describes investigations made, tracing the development of the time and distance-measuring parts of the apparatus and showing their combination for simultaneous use. 6500 w. Jour Fr Inst—Nov., 1897. No. 16323 D.

Valuation.

The Valuation of Textile-Manufacturing Property. Charles T. Main. A discussion of the methods of determining value. 13000 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16817 D.

Wire.

A Convenient Form of Wire-Testing Machine. Arthur L. Rice. Illustrated description. 300 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16822 D.

Wire. A. L. Orton, in *Sibley Journal of Engineering*. Gives history of the development and much general information. 2000 w. Age of St—Nov. 20, 1897. No. 16765.

Wire Rope.

Influence of Materials and Construction upon the Strength of Wire Rope. (Einfluss des Materials und der Konstruktion auf die Festigkeit von Drahtlitzen.) Prof. Rudeloff. A most exhaustive report upon the tests made at the Charlottenburg laboratory. A very valuable contribution to engineering knowledge. 30000 w. Mitt a d Kgl Tech Versuchsanstalt—Parts III and IV, 1897. No. 16448 H.

MINING AND METALLURGY.

COAL AND COKE.

British India.

The Production of Coal in British India in 1896. Shows the encouraging prospects for this growing industry. 1300 w. Ind & East Engr—Oct., 1897. No. 16688 D.

Brown Coal.

The Grottau Brown Coal Deposit, North Bohemia. Fried. Katzer, in *Oesterreichische Zeitschrift für Berg- und Hüttenwesen*. Describes the deposit and working. 900 w. Col Guard—Nov. 5, 1897. No. 16652 A.

The Lignite Beds at Grottau in Northern Bohemia. (Die Grottauer Braunkohlenablagerung in Nordböhmen.) Describing these important deposits of soft brown-coal, with map and geological sections. Two articles, 1 plate. 5000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 9, 16, 1897. No. 16484 E.

Coal Testing.

Apparatus for Testing Coal Samples. M. A. Dory. From a communication to the Société des Ingénieurs des Mines du Hainaut. Illustrated description of apparatus and its operation. 1300 w. Col Guard—Nov. 12, 1897. No. 16782 A.

Coke Oven.

The Improved Simon Carves Coke Oven. Illustrated description of this well-known oven in its improved form. 900 w. Eng & Min Jour—Nov. 13, 1897. No. 16616.

Coke Plant.

A Model Coke Plant. Illustrated description of coke plant No. 2, of the Oliver Coke and Furnace Company, near Uniontown, Pa. 700 w. Mines & Min—Nov., 1897. No. 16627 C.

The Otto-Hoffmann Coke-Oven Plant at Glassport, Pa. Illustrated description. 1800 w. Ir Age—Nov. 11, 1897. No. 16534.

Coking.

Half a Century of Coke and Coking Processes. Part first gives statistics of recent progress, and the economy possible from the utilization of by-products and waste gases. 2500 w. Ir & Coal Trds Rev—Nov. 12, 1897. Serial. 1st part. No. 16785 A.

Laborers.

Anthracite Mine Laborers. G. O. Virtue. Shows that their lot in the Pennsylvania region has never been an easy one, and that at present it is even harder than ever. 22000 w. Bul Dept of Labor—Nov., 1897. No. 16805 D.

South Africa.

The Middelburg Coalfields (South Africa). Herbert Lloyd. Describes the region, formations, quality, etc.; also other minerals to be found in this district. 1100 w. Col Guard—Nov. 12, 1897. No. 16781 A.

COPPER.

Michigan.

Brief Description of the Calumet and Hecla Mine, Lake Superior, Michigan. E. McCormick. A diagram, showing method of procedure, and details of work are given. 1000 w. Min & Sci Pr—Nov. 13, 1897. No. 16699.

GOLD AND SILVER.

Australia.

Benalla Goldfield (Vic.) W. H. Ferguson. Report, with plan, of this field, describing the reefs, alluvial claims, and prospecting. 2000 w. Aust Min Stand—Oct. 21, 1897. No. 16793 B.

First Impressions of Westralia. T. A. Rickard. Brief description of Western Australia. 1200 w. Eng & Min Jour—Nov. 20, 1897. No. 16724.

Resources of the Northern Territory. W. G. Stretton. From the *Northern Territory Times*. Reports the minerals found and the mines worked. Gold is the most important mineral. 2300 w. Aust Min Stand—Oct. 21, 1897. No. 16794 B.

Crucibles.

Notes on Assaying Ground-Graphite Crucibles. Andrew F. Crosse. Describes a method found to give satisfactory results in making assays on this class of material. Short paper with discussion, including interesting notes by the president, Charles Butters, on the gold that is found in the by-products. 5700 w. Chem & Met Soc of S Africa—Sept. 18, 1897. No. 16322 D.

Cyanid Process.

Charcoal in Cyaniding. Norman Danvers Power. Gives information relating to the use of this precipitant, and directions for the process. 1500 w. Aust Min Stand—Oct. 14, 1897. No. 16769 B.

Cyaniding Sulphide Gold Ores. R. Recknagel. Remarks on this subject, causes of failures, differences in extraction, &c. 3300 w. Eng & Min Jour—Nov. 13. 1897. No. 16617.

Gold, Zinc, and Electrolysis. (Gold, Zink, und Elektrolyse.) A paper by E. Andreoli discussing the Siemens method of reducing gold from a cyanid solution by electrical deposition, instead of zinc shavings. 3500 w. Elektrochemische Zeitschr—Oct., 1897. No. 16460 B.

Dredging.

Gold Dredging in Montana. Eugene B. Braden. Illustrated description of dredging experiments in this state, with their results. 2500 w. Eng & Min Jour—Nov. 20, 1897. No. 16722.

Notes on Dredging for Gold. John W. Gray. Information of dredges used and the success of the work both in America and New Zealand. 2300 w. Min & Sci Pr—Nov. 13. 1897. No. 16698.

Gold Ore.

The Estimation of Gold in Ore, and Data on Dry-Crushing Experiments. Franklin White. Read before the Chemical and Metallurgical Society of South Africa. Tables showing the possibility of assaying ore before crushing with sufficient accuracy to afford very useful information. One set of calculations refers to wet milling, one to a dry-crushing test. 1700 w. Chem & Met Soc of S Africa—Oct. 16, 1897. No. 16763 D.

Gold Seeking.

Gold Dredging and Gold Saving. Perry F. Nursey. Describes the invention of Charles Ball for automatically securing the gold. Also reviews the systems of dredging which have been used from the earliest time to the present. 1800 w. Ind & Ir—Oct. 29, 1897. No. 16382 A.

Klondike.

How Gold is Mined on the Klondike and the Chances of Fortune There. A statement of facts showing that the region is not nearly as rich as was California in 1850. 1500 w. Eng & Min Jour—Nov. 27, 1897. No. 16869.

Railways to the Klondike. An account of the various projects for furnishing improved transportation to the Alaskan gold fields. Map. 1200 w. Ry Age—Oct. 29, 1897. No. 16361.

Route to the Yukon. A description of the overland route via Juneau, over the White and Chilkoot passes, and down the Yukon, as given in the Juneau *Mining Record*. 2200 w. W Min Wld—Nov. 6, 1897. No. 16546.

The Klondike Placers. T. K. Rose. Brief history of the district, with description of the gold fields, and methods of working. 1700 w. Nature—Oct. 28, 1897. No. 16384 A.

Ladue Company.

The Joseph Ladue Company's Directors Incredible Credulity. Editorial criticism of the prospectus of this company. 2700 w. Eng & Min Jour—Nov. 27, 1897. No. 16870.

Mother Lode.

A Few Miles of the Mother Lode in California. R. W. Petre. The almost uniform results of deep mining on a few miles of the Mother Lode has caused it to be regarded by many as infallible. 2000 w. Eng & Min Jour—Nov. 27, 1897. No. 16872.

New Zealand.

Gold Mining at Preservation Inlet. Richard Allen. Information of this locality and how it was discovered, and of the mines located and worked. 2000 w. New Zealand Mines Rec—Oct. 16, 1897. No. 16804 B.

Nuggets.

World's Big Nuggets. Interesting account of the finding of nuggets in curious places, and under peculiar circumstances. 1500 w. W Min Wld—Nov. 20, 1897. No. 16795.

Placer Mining.

The American Hill Placer Mine, Idaho. Edmund Juessen. Illustration, with description of methods of working. 800 w. Eng & Min Jour—Nov. 27, 1897. No. 16871.

Refining.

Metal-Refining Methods. (Metallhüttenwesen.) C. Schnabel. A discussion of the latest refining methods for gold and silver including the cyanid treatment of gold ores in various parts of the world, and the Stetefeldt and Dewey-Walther silver processes. Two articles. 9000 w. Zeitschr de Ver Deutschr Ing—Oct. 9, 23, 1897. No 16403 G.

Slimes.

The Treatment of Battery Slimes. Discussion on J. R. Williams' paper by the society members. 2800 w. Chem & Met Soc of S Africa—Sept. 18, 1897. No. 16321 D.

Smelting.

British Columbia Smelting Development. Reviews the present conditions and the opportunities for development, giving report of numerous projects of great importance. 1800 w. Can Min Rev—Oct., 1897. No. 16313 B.

Witwatersrand.

The Economic Value of the Main Reef (Witwatersrand). Fischer Wilkinson. Read before the society. Statistically investigating the value of the Main Reef series, how much is paying now and the future prospects. 2700 w. Chem & Met Soc of S Africa—Oct. 16, 1897. No. 16764 D.

The Gold Mines of the Witwatersrand (Mines d'Or du Witwatersrand.) A review of the relation of the variations of the prices of mining shares to the cost of development, based upon data obtained by M. Perrier de la Bathie, from the mines of the Transvaal. 4500 w. Le Génie Civil—Oct. 23, 1897. No. 16423 D.

IRON AND STEEL.

Address.

Presidential Address of F. W. Paul at the Glasgow Meeting of the West of Scotland Iron and Steel Institute. Deals with blast-furnaces and by-products, open-hearth steel, melting furnaces, Bertrand-Thiel process, Stockman process, &c. 6500 w. Ir & Coal Trds Rev—Oct. 29, 1897. Serial. 1st part. No. 16507 A.

American Steel.

American Steel Supreme. D. Allen Willey. Showing that the price of fuel and supply of ore enable America to supply the world, if transportation rates can be obtained on an equitable basis. 1700 w. Mfrs Rec—Nov. 26, 1897. No. 16836.

Axles.

Steel and Iron Axles. R. A. Mould. Read before the National Railway Master Blacksmiths' Assn. Information respecting the wearing qualities of iron and steel axles, showing the superiority of the latter. 1600 w. Ir & St Trds Jour—Oct. 30, 1897. No. 16356 A.

Belgium.

Coal and Iron in Belgium (Kohle und Eisen in Belgien.) A statistical and comparative view of the Belgian coal and iron industry from 1870 to 1895. 6000 w. Stahl und Eisen—Nov. 15, 1897. No. 16479 D.

British Steel.

The British Steel Industry. The returns for the first six months of the current year show the largest output ever produced in the same time in any European country. 1000 w. Arch, Lond—Oct. 22, 1897. No. 16287 A.

Edison Works.

Magnetic Ore Separation at Edison, New Jersey, U. S. A. This interesting plant is illustrated and described, and information relating to its working is given. 3200 w. Engng—Nov. 12, 1897. No. 16736 A.

The Edison Iron-Ore Concentrating Works at the Ogden Mines, Edison, N. J. Particulars of the works, methods and machinery. 1800 w. Eng News—Nov. 11, 1897. No. 16567.

Electrolysis.

See Electrical Engineering, Electrochemistry.

Impact.

Cast Iron under Impact. W. J. Keep. Describes experiments made to determine the influence of shock on cast iron, showing incidentally the use of mechanical analyses in determining the cause of physical changes which take place in cast iron. 8400 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16819 D.

Iron Industry.

The Iron Industry of Great Britain Sixty Years Ago. Interesting information from a report of a journey through the iron-manufacturing districts. 3200 w. Ir & Coal Trds Rev—Nov. 5, 1897. No. 16660 A.

Iron Melting.

See Mechanical Engineering, Shop & Foundry.

Magnetism.

The Ferromagnetic Properties of Iron and Steel. J. A. Fleming. A lecture delivered to the Sheffield Society of Engineers and Metallurgists. A review of the chief facts concerning ferromagnetism, with explanations. 3800 w. Elect'n, Lond—Oct. 22, 1897. Serial. 1st part. No. 16283 A.

Magnetite.

On the Magnetite Belt at Cranberry, North Carolina, and Notes on the Genesis of this Iron Ore in General in Crystalline Schists. James P. Kimball. Describes topography, formation and developments; gives analyses and interesting particulars. 4300 w. Am Geol—Nov., 1897. No. 16320 D.

Phosphorus.

The Rapid Determination of Phosphorus. (Schnelle Phosphorbestimmung.) A brief account of an improved method of determining the percentage of phosphorus in iron by the magnesia process, as used by M. Wdowiszewski, chemist of the Kulebaki iron works. Four hours time is sufficient, instead of 1 to 3 days, as formerly. 1500 w. Stahl und Eisen—Oct. 1, 1897. No. 16471 D.

Reducibility.

Methods of Determining the Reducibility of Iron Ores. (Verfahren zur Bestimmung der Reducirbarkeit der Eisenerze.) Prof. J. Wiborg. A paper read before the International Association for Testing Materials, at Stockholm, 1897. Description of various methods, and table of results for different ores. Two articles. 7500 w. Stahl und Eisen—Oct. 1, 15, 1897. No. 16470 G.

Steel Making.

The Tropenas Process of Steel Making. A letter from the Imperial Steel Works, of Sheffield, Eng., testifying to the success of the process, with summary of claims made by the inventor in his specification, and comments of Dr. Henry M. Howe. 2700 w. Eng News—Nov. 4, 1897. No. 16368.

Wrought Iron.

Hints About Iron. B. F. Spalding. Deals with different heats, stiff white heats, bending elastic and inelastic pieces, cold-short iron, good but unprofitable iron, tests, &c. Ill. 2500 w. Am Mach—Nov. 11, 1897. No. 16562.

MINING.

Accidents.

Compensation for Mining Accidents in Germany. Dr. Beumer in *Stahl und Eisen*. On the statistics published in the recently issued report of the Miners' Guilds (Mutual Aid) Assn. as to the accidents which have occurred in German mining during the nine years ending 1895. 2500 w. Ir & Coal Trds Rev—Oct. 29, 1897. No. 16508 A.

Dykes.

To Trace an Invisible Dyke. George H. Stone. Describes a new method by which the course of a dyke may be discovered from sand, rocks and boulder beds on the surface. 1700 w. Mines & Min—Nov. 1897. No. 16628 C.

Electric Locomotive.

The Electric Locomotive in Mining and Railway Work. Historical review with illustrations. 2200 w. Ir & Coal Trds Rev—Nov. 12, 1897. No. 16784 A.

Explosives.

Experiments with Explosive Gas Cartridges. (Ueber Versuche mit Knallgaspatronen.) Describing experiments with a compressed mixture of oxygen and hydrogen, to be used as a mining explosive. The charge is ignited by an electric spark, and safety, power, and freedom from noxious fumes are claimed. 1500 w. Glückauf—Nov. 6, 1897. No. 16483 B.

Fans.

Ventilating Fans. Discussion of a paper by W. G. Walker, read before the English Institution of Mechanical Engineers. 4000 w. Engng—Nov. 5, 1897. No. 16622 A.

Hydraulic Mining.

Some Notes on Hydraulic Mining. Augustus J. Bowie. Some of the difficulties encountered are mentioned showing how hazardous anticipated estimates of yield are. 2500 w. Eng & Min Jour—Oct. 30, 1897. No. 16264.

Hygrometry.

The Hygrometric Saturation of the Earth's Crust (Die Hygrometrische Sättigung der Erdrinde.) Discussing the various capacities for moisture of the different constituents of the earth's crust, with relation to the accumulation of water in mines. Two articles, 4500 w. Glückauf—Oct. 16, 23, 1897. No. 16482 E.

Machinery.

Electric Mining Machinery. J. N. Bulkley. Some investigations in regard to cost of operation in various mines. Figures obtained from mine officials. 5500 w. Mines & Min—Nov. 1897. No. 16630 C.

Mine Transmission.

See Electrical Engineering, Power.

Mining Law.

Proposed Change in Federal Mining Law. Address of W. S. Keyes before the California State Miners' Assn. on the amendments required to the existing statutes of the United States concerning mineral lands. 5500 w. Min & Sci Pr—Nov. 6, 1897. No. 16626.

The Ontario Mines Act. R. W. Raymond. Discusses some of the features. 1800 w. Can Min Rev—Oct., 1897. No. 16312 B.

The Proposed Revision of the United States Mining Law. R. W. Raymond. Editorial discussion of the improvements urged by Francis T. Freeland. 1100 w. Eng & Min Jour—Oct. 30, 1897. No. 15261.

Mining Methods.

Improvements in Prussian Mining Methods. From an official report published by the *Zeitschrift für Berg- Hutten- und Salinenwesen*, and reproduced by *Glückauf*. Part first deals with getting coal; the hand boring, rock drilling, explosives, wedging, laying-out and conduct of workings, timbering, pumping, hauling, &c. Ill. 4500 w. Col Guard—Oct. 22, 1897. Serial. 1st part. No. 16267 A.

Mining Region.

A Sketch of the Mining Fields of British Columbia and the Great Northwest. Arthur Lakes. Their geological formations, nature of the ore veins, location of placers, and physical features of the country; with some facts in regard to the production. 6800 w. Mines & Min—Nov., 1897. No. 16629 C.

New Zealand.

Progress of Mining in New Zealand. Henry A. Gordon. Abstract of presidential address delivered at the first meeting of the New Zealand Institute of Mining Engineers. Historical Review. 2800 w. Col Guard—Nov. 12, 1897. No. 16783 A.

Rackarock.

Is Rackarock Safe? Claiming that it has been proved a safe and suitable explosive for mining purposes. 1400 w. Aust Min Stand—Sept. 30, 1897. No. 16766 B.

Ratable Value.

Ratable Value of Mines. Discusses the letting of mines in England. 2400 w. Col Guard—Oct. 29, 1897. No. 16504 A.

Shaft Sinking.

McCulloch's Frame for Sinking Round Shafts. Illustrated description of a device enabling them to be sunk with economy and speed. 800 w. Engr, Lond—Oct. 29, 1897. No. 16514 A.

Sinking by the Poetsch Process at a Brux Lignite Mine. C. Petrlik. From a communication to the *Allgemeine Bauzeitung*, of Vienna. Describes a very difficult piece of work, caused by a thick bed of quicksand. Ill. 2500 w. Col Guard—Nov. 12, 1897. No. 16780 A.

Training.

The Training of Mining Engineers. Part first discusses why the present system, or systems, have not worked satisfactorily, or why they have served their time. The next paper will offer suggestions. 3500 w. Col Guard—Nov. 5, 1897. Serial. 1st part. No. 16651 A.

Ural.

The Ural Excursion of the International Geological Congress. Remarks on the localities visited which produced rare minerals and the more important mining centers. 3800 w. Engr, Lond—Nov. 12, 1897. No. 16732 A.

MISCELLANY.

Alloys.

Alloys. Chandler Roberts-Austen. First lecture on this subject, delivered before the Society of Arts, London, on March 15, 1897. It is the beginning of the fourth series on this subject, dealing with recent investigations and results. 4000 w. Jour Soc of Arts—Oct. 22. 1897. No. 16245 A.

Microscopic Study of Alloys. T. K. R. Explanation of the value of microscopic analysis of alloys, with illustrations. 900 w. Nature—Nov. 4, 1897. No. 16649 A.

Asbestos.

Diluvial—A New Form of Asbestos. Robert H. Jones. Read before the Asbestos Club, Black Lake. Information relating to this curious fibre and to its origin or formation. 3500 w. Can Min Rev—Oct., 1897. No. 16314 B.

Basic Slag.

A New Competitor for Basic Slag. (Ein Neuer Wettbewerb für die Thomasschlacke.) The magnetic separation of certain Swedish magnetic ores furnishes a quantity of apatite, which as a phosphate fertilizer bids fair to compete with slag from the Thomas basic steel process. 2000 w. Stahl und Eisen—Nov. 1, 1897. No. 16475 D.

Blowing Engines.

See Mechanical Engineering. Motors.

China.

China and Her Minerals. Perry F. Nursey. Considers the vast unutilized mineral wealth. Coal is the most abundant mineral. 1700 w. Ind & Ir—Nov. 12, 1897. No. 16777 A.

Geological Congress.

The International Geological Congress at St. Petersburg. Dr. Persifor Frazer. Interesting account of excursions arranged by the Russian government, which enabled geologists to get a clear idea of the extent and value of the mineral fields, with other interesting information. 2500 w. Eng & Min Jour—Nov. 20, 1897. No. 16723.

Hardness.

A New Indentation Test for Determining the Hardness of Metals. William Cawthorne Mervin. Reviews the methods previously used for determining hardness, and describes the author's method. Ill. 1500 w. Prac Eng—Oct. 29, 1897. Serial. 1st part. No. 16517 A.

Metallography.

Metallography as a Method of Research. (Die Metallographie als Untersuchungs Methode.) An important paper by M. Osmond upon the value of the study of etched sections in investigating the quality and nature of metal; presented at the International Testing Congress at Stockholm, 1897. 7500 w. Stahl und Eisen—Nov. 1, 1897. No. 16476 D.

Metals.

The Progress of Metallurgy and Metal Mining in America during the last Half-Century. James Douglass. Gives the history of these industries in Mexico, United States and Canada, considering each metal separately and the methods employed; also discussion. 138000 w. Jour Socy Arts—Nov. 26, 1897 No. 17000 A.

Mirrors.

Ancient Mirrors of Glass Backed with Metal. (Sur les Miroirs de Verre Doublé de Métal dans l'Antiquité.) Account, by M. Berthelot, of some interesting archæological specimens showing that the ancient Romans possessed the art of producing reflecting surfaces by backing glass with metal. 3000 w. Comptes Rendus—Oct. 4, 1897. No. 16432 B.

Nickel.

Reputed Nickel Mines in Minnesota. Horace V. Winchell. An account of fraud in a mining enterprise. 1600 w. Eng and Min Jour—Nov. 13, 1897. No. 16615.

Oil Wells.

Boring Oil Wells at Sea. Illustrated description of these wells on the sea shore near Santa Barbara, California. 800 w. Sci Am—Nov. 27, 1897. No. 16800.

The Caucasus Oil Field in 1897. Report of the adverse conditions which have so greatly affected the export trade. 700 w. Am Mfr & Ir Wld—Nov. 12, 1897. No. 16773.

Pumice Stone.

The Deposits of Volcanic Ash in Nebraska. E. H. Barbour. From a paper published in the report of the Nebraska State Board of Agriculture for 1896. Gives information of the extent, deposits, chemical composition, &c. Ill. 800 w. Eng & Min Jour—Nov. 6, 1897. No. 16388.

Rating.

Rating of Mines. Information of English law on this subject, with several cases illustrating contested points. 2000 w. Col Guard—Oct. 22, 1897. No. 16265 A.

Salt Wells.

The Great Salt Wells at Tsz-Lin-Ching. E. H. Parker. Description of these interesting wells in China, and the principle on which they are worked. 3600 w. U. S. Cons Repts—Nov., 1897. No. 16520 D.

Smelting.

The Smelting of Mixed Zinc and Iron Ores at Bethlehem, Pa. Josef von Ehrenwerth. Describes the process through which the ore is passed. 1100 w. Col Guard—Oct. 22, 1897. No. 16268 A.

Tin.

Tin Mining in Perak. A report of this district for 1896, and explanation of causes that lessened the output. 900 w. Ind Engng—Oct. 16, 1896. No. 16689 D.

Topography.

Geology in its Relation to Topography. John C. Branner. The origin and controlling factors of some of the more important topographic forms are pointed out, and the necessity of a knowledge of structural geology to the topographer, is shown. 8000 w. Pro Am Soc of Civ Engs—Oct., 1897. No. 16228 F.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Acetylene.

An Acetylene Gas Lamp for Bicycles. Illustrated description of lamp made by the George H. Clowes Mfg Co., of Waterbury, Conn. 700 w. Sci Am—Nov. 13, 1897. No. 16557.

An Italian Acetylene-Gas Generator. Describes the Sardi Generator, and illustrates it in sections. 700 w. Ind & Ir—Nov. 12, 1897. No. 16779 A.

Naphey's Automatic Acetylene-Gas Generator. Illustrated description of a machine which claims to remove all possibility of danger. 800 w. Met Work—Nov. 20, 1897. No. 16712.

The Acetylene-Gas Explosion. E. A. Gay. An account of the disaster in the shop of Valentine J. Long, Jr., at Rochester, N. Y. Ill. 855 w. Am Mach—Nov. 11, 1897. No. 16560.

Address.

President s Address at Meeting of American Gas-Light Association, at Old Point Comfort. Charles H. Nettleton. Touches on many subjects of interest to the gas industry. 5500 w. Pro Age—Nov. 1, 1897. No. 16306.

Burners.

Report of Burner Stoppages. Paul Doty. Read before the American Gas-Light Assn. Results of experience, experiment and research to discover the cause and cure of troublesome deposits. 7000 w. Pro Age—Nov. 1, 1897. No. 16307.

Boston, Mass.

Boston's Big Gas Project. From *Boston Daily Advertiser*. An account of the project to establish a great coke and gas manufacturing plant, giving the important features of the undertaking. 1000 w. Am Mfr & Ir Wld—Oct. 29, 1897. No. 16294.

Charging.

Charging Apparatus for Small Works. R. Watson. Read at meeting of Southern District Assn. of Gas Engineers and Managers, in England. Describes a method of scoop-charging. Discussion. Ill. 3300 w. Gas Wld—Nov. 13, 1897. No. 16776 A.

Consolidation.

Gas Interests Consolidating. Explains the gas situation in Chicago and in Greater New York. 1000 w. Bradstreet's—Nov. 6, 1897. No. 16340.

Cyanids.

Cyanids in Gas Manufacture. Herman Poole. Discusses the question of the quantity of cyanids from gas that is wasted, and how to remedy the matter. 3500 w. Am Gas Lgt Jour—Nov. 22, 1897. No. 16788.

Distribution.

Suggested Examinations in Gas Distribution. Norton H. Humphrys. Urging the proper inspection of the pipes and accessories for the supply and consumption of gas. 3000 w. Jour Gas Lgt—Oct. 26, 1897. No. 16357 A.

Gas Power Plant.

Tests Made on a Modern Gas Power Plant at a Textile Factory. An account of tests of a Thwaite gas generator of 300 I. H. P. capacity. Ill. 300 w. Elec Rev, Lond—Nov. 5, 1897. No. 16614 A.

Gas Power.

See Mechanical Engineering, Power and Transmission.

Gas Producer.

The Mond Gas-Producer Plant. Abstract of the discussion on paper by H. A. Humphrey, read at a meeting of the Institution of Civil Engineers. 7500 w. Col Guard—Oct. 29, 1897. Serial. 1st part. No. 16506 A.

The Mond Gas-Producer Plant and Its Application. Herbert Alfred Humphrey. Read before the Institution of Civil Engineers, England, March, 1897. Deals with recent advances in gaseous fuel, describes the Mond producer and recovery plant, giving tests, applications, etc., with tabulated data. Ill. 9600 w. Col Guard—Oct. 22, 1897. No. 16266 A.

The Mond Gas-Producer Plant. Discussion by correspondence of a paper by H. A. Humphrey, read before the Institution of Civil Engineers. 5000 w. Col Guard—Nov. 5, 1897. No. 16653 A.

Good Gas.

Why Good Gas? A. W. Wilkinson. Read before the Society of Gas Lighting. Discusses the various lights with which gas has had to compete, and the necessity of making the best gas even if it increases the cost. 1800 w. Am Gas Lgt Jour—Nov. 1, 1897. No. 16291.

Illuminant.

A New Illuminant. Reports an improvement in incandescent gas-burners, invented by Ernest Salzenberg, director of the gas-works of the city of Crefeld, Prussia. 200 w. Cons Repts—Dec., 1897. No. 16575 D.

Illumination.

Some Further Experiments on Interior Illumination. Alten S. Miller. Read before the American Gas Light Assn. A continuation of the study of this subject, giving results of experiments made. Short discussion. 1800 w. Am Gas Lgt Jour—Nov. 22, 1897. No. 16787.

The Illumination of Inclosed Space. W. H. Birchmore. Part first states the problem and the means of solving it, with review of progress in interior illumination. 4400 w. Am Gas Lgt Jour—Nov. 29, 1897. Serial. 1st part. No. 16887.

Leakage.

Leakage. J. M. Rusby. An outline of the methods employed and experience gained by the writer. Read before the American Gas Light Assn. 2400 w. Pro Age—Nov. 15, 1897. No. 16669.

Materials.

Unloading, Distribution, and Re-loading of Materials in Gas-Works. Mr. Meiklejohn.

Read before the Midland Assn. of Gas Managers, at Birmingham, Eng. Description of the most useful forms of the New Conveyor Company's plant at Smethwick. Ill. 2000 w. Jour Gas Lgt—Nov. 2, 1897. No. 16589 A.

Naphthalene.

A Method Successfully Employed to Obviate Trouble from Naphthalene. K. M. Mitchell. Read before the American Gas Light Assn. States the difficulties met with and the method that finally brought success. Also discussion. Ill. 3500 w. Am Gas Lgt Jour—Nov. 1, 1897. No. 16292.

Purifying.

A Quadruplex Purifying Box; Why Not? F. H. Shelton. Read before the American Gas Light Assn. Calls attention to objectionable features in the present design, with illustrated description of design of writer claiming to be a decided improvement. 5500 w. Pro Age—Nov. 1, 1897. No. 16308.

Chemical Notes on Purification. Henry A. Mather. Read at meeting of the Am. Gas Light Assn. Reviews the formulas of the reaction between sulphuretted hydrogen and hydrated oxid of iron, and considers methods of chemical treatment of iron purifying materials. 2400 w. Am Gas Lgt Jour—Nov. 15, 1897. No. 16609.

Retorts.

Retort Setting and Retort Heating. C. C. Carpenter. Read at meeting of Southern District Assn. of Gas Engineers and Managers, in England. Considers the method of heating by the supply and even distribution of fuel gas to be recommended, and discusses the problem generally. Discussion. 5000 w. Gas Wld—Nov. 13, 1897. No. 16775 A.

Rust.

Rust Deposits in House Pipes. F. B. Wheeler. Read at meeting of the Am. Gas Light Assn. Investigates what the rust consists of and where it comes from. Also discussion. 5500 w. Am Gas Lgt Jour—Nov. 15, 1897. No. 16608.

Stoking Machinery.

New Stoking Machinery at the Bury Corporation Gas-Works. Gives an account of a visit of inspection, by the Gas Committee, and of the new stoking machinery driven by compressed air, recently fitted to one section of the retort-house. 2000 w. Jour Gas Lgt—Oct. 26, 1897. No. 16358 A.

Water Gas.

Recent Advances in Lighting by Water Gas. Abstract translation of papers by H. Strache and H. Dicke, published in the *Journal für Gasbeleuchtung*. 3500 w. Jour Gas Lgt—Oct 26, 1897. No. 16359 A.

SEWERAGE.

Chicago.

Financial Statement of the Sanitary District of Chicago. Tabular statement to Oct. 1, 1897, showing that nearly $25,000,000 have been expended on this work. 700 w. Eng News—Nov. 11, 1897. No. 16570.

Disposal Works.

Some Considerations on the Designs of Town Sewerage Schemes. Frank Wood. Discusses the basis on which sewerage schemes are designed, with a note on the combined *versus* the separate systems. 4500 w. Engr, Lond—Nov. 12, 1897. No. 16730 A.

Pumping Machinery.

Sewage Pumping Machinery at Budapest, Hungary. O. N. Mueller, Jr., in *Zeitschrift des Vereines Deutscher Ingenieure*. Abstract translation by O. J. Marstrand. Illustrated description with results of official tests. 1000 w. Eng News—Nov. 4, 1897. No. 16363.

Separate Sewage.

The Advantages of the Separate Sewage System. W. M. Watson. Presents the superiority of the separate system to the combined system. 1400 w. Can Eng—Nov., 1897. No. 16607.

Sewer Construction.

Electric Navigation in a Sewer. Explains the numerous ways in which electricity was employed in the construction of a masonry sewer at Worcester, Mass. 1300 w. Eng Rec—Oct. 30, 1897. No. 16247.

Municipal Practice in Sewer Construction, Medford, Mass. T. Howard Barnes. Historical account of the work and the important details of the system. 2000 w. Eng Rec—Oct 30, 1897. No. 16249.

Sewers.

Laying Out Sewer Work. W. K. Hatt. Some notes descriptive of the field work in laying out sewer lines for construction, the operations of giving line and grade. 1700 w. Pro of Purdue Soc of Civ Engs—1897, No. 16810 D.

Test.

Test of Centrifugal Pump and Calibration of Weir at the Bridgeport Pumping Station, Chicago, Ill. R. C. Carpenter. Description of plant and of test made to determine the efficiency and capacity of the various pumps at the Sewerage Pumping Station at Bridgeport, Chicago, Ill. 5500 w. Trans Am Soc of Mech Engs—Dec., 1897. No. 16834 D.

Ventilation.

Sewer Ventilation. J. W. Hughes. Read before the American Public Health Assn. at Philadelphia. Opposing what is known as the intercepting trap, with reasons. 1300 w. Metal Work—Nov. 6, 1897. No. 16335.

STREETS AND PAVEMENTS.

Asphalts.

One Year's Work with a Chemical Laboratory for Testing Asphalts. George W. Tillson. An account of the work done at the laboratory in Brooklyn. 2500 w. Munic Engng—Nov., 1897. No. 16303 C.

Street Cleaning.

The Street-Cleaning Problem. J. W. Howard. Condensed from an address at the banquet of the Union League Club of Chicago. Contains much interesting information and discusses the cleaning of various cities, urging a larger

appropriation for Chicago. 3500 w. Munic Engng—Nov., 1897. No. 16305 C.

Vienna.

City Improvements between the Park and Theatre in Vienna. (Die Regulirung des Stadttheiles vom Stadtparke bis zum Theater a. d. Wien.) Jos. Hudetz. A discussion of several plans for cutting new streets, and accompanying municipal improvements. The author offers a substitute plan for that of the city engineers of Vienna. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 22, 1897. No. 16410 B.

WATER SUPPLY.

Baltimore Mains.

Laying Large Water Mains in Baltimore. Describes some special methods of machinery used to promote economy and rapidity and prevent street obstruction. Ill. 800 w. Eng Rec —Nov. 20, 1897. No. 16726.

Cincinnati, O.

The New Cincinnati Water-Works. An account of a new intake to be built sufficiently above the mouth of the Miami to avoid all contamination except from remote cities and towns. Map. 1500 w. Eng Rec—Nov. 27, 1897. No. 16877.

Coating Pipes.

Coating of Cast-Iron and Steel Riveted Pipes. Condensed from the report of the special committee on coating of cast-iron and steel-riveted pipes. George H. Benzenberg, chairman to American Society of Municipal Improvements, at Nashville, Tenn. 3800 w. Munic Engng—Nov., 1897. No. 16304 C.

Danville, Illinois.

An Important Water-Works Decision. Text of an important decision of the Illinois Supreme Court, rendered by Chief Justice Phillips, maintaining that the city has no more right to break a contract than a private party. 2500 w. Eng Rec—Nov. 20, 1897. No. 16727.

Ground Water.

The Collection of Groundwater. (Ueber Grundwasserfassungen.) An investigation of the conditions which govern the accumulation of ground water and the formation of subterranean streams and pools, with special view to the use of such sources of water supply. 6000 w. Gesundheits-Ingenieur—Oct. 31, 1897. No. 16415 B.

India.

Bellary Water Supply—Copper Hills Scheme. Hormusji Nowroji. The conditions of this region in India are described, and the work being done, with costs of the Copper Hill supply. 1800 w. Ind Engng—Sept. 25, 1897. No. 16231 D.

Bellary Water Supply. D. McNeil Campbell. Brief discussion of the three schemes proposed. 1100 w. Ind Engng—Oct. 9, 1897. No. 16654 D.

New York.

The Water Supply of the City of New York. Information relating to the Forty-second street reservoir and the arrangements for abandoning it. 800 w. Fire & Water—Nov. 6, 1897. No. 16394.

Organisms.

Some Observations on the Growth of Organisms in Water Pipes. George C. Whipple. Discussion of this subject based on the biological observations made by the Boston Water Works, with the results. 5500 w. Jour N Eng Water Works Assn—Sept., 1897. No. 16591 F.

Petrolea, Ontario.

The Petrolea Water Works. Gives the plan adopted, describing the work. 2000 w. Can Eng—Nov., 1897 No. 16606.

Pumping Engine.

Pumping Engine, Fairhaven, Massachusetts. Illustrated description. 1500 w. Fire & Water—Oct. 30, 1897. No. 16259.

Purifying.

A Water Purifying Plant. Howard Stillman. The Clark process, adding milk of lime and carbonate of soda successively, is used at Port Los Angeles, Cal., successfully for purifying locomotive feed water. Details of apparatus and method are given. Ill. 4000 w. Trans Am Soc of Mech Engs—Dec., 1897. 16833 D.

Schuylkill River.

The Upper Schuylkill River. Oscar C. S. Carter. Describes the river and the conditions affecting it, as related to the water-supply of Philadelphia, Pa., and several towns along its banks. 4400 w. Jour Fr Inst—Nov., 1897. No. 16324 D.

Service Pipes.

Service Pipes Defects and the Remedy. George F. Chace. The writer believes the best service pipe at present in the market is tin-lined iron pipe. Gives account of experience. Discussion. 6000 w. Jour N Eng Water Works Assn—Sept., 1897. No. 16593 F.

Tower.

Standpipe and Tower at Lawrence. Illustrated description of a stand pipe enclosed in a stone and brick tower for the new high-service water system of this city in Massachusetts. 1400 w. Fire & Water—Nov. 6, 1897. No. 16393.

Water and Sewage.

Notes on Water Supply and Sewage Disposal in Massachusetts and Rhode Island. Information obtained on a recent short trip. 1600 w. Eng News—Nov. 25, 1897. No. 16843.

Water Purification.

The Purification of Drinking Water and Sewage. (Reinigung von Trink- und Abwasser.) A paper by Dr. Zirn of Hamburg, dealing mainly with the purification of sewage in order to avoid contamination of river water. 2500 w. Gesundheits-Ingenieur—Oct. 15, 1897. No. 16414 B.

Water-Works.

The Kowloon Water-Works. W. Cheetham. Brief description of these works in India, with costs. 800 w. Ind Engng—Sept. 25, 1897. No. 16230 D.

Woonsocket.

Woonsocket Water-Works Reservoir and Dam No. 3. Byron I. Cook. Illustrated description of this work in Rhode Island followed by discussion. 5500 w. Jour N Eng Water Works Assn—Sept., 1897. No. 16592 F.

MISCELLANY.

Cost of Service.

Cost of Service to Users and Taxpayers. Allen R. Foote. Read before the League of American Municipalities, Sept., 1897. Considers this the only proper basis of comparison to show the relative economic advantages derived from private and municipal ownership and operation of water, gas and electric-lighting works. Investigations made. 8800 w. Elec Eng, N, Y. —Nov. 4, 1897. No. 16329.

Garbage.

Disposal of Garbage and Refuse. Report of the committee on this subject, presented at the meeting of the American Public Health Assn. at Philadelphia. 4200 w. Eng Rec—Nov. 6, 1897. No. 16349.

The Disposal of Garbage and Refuse. Letters from James H. Fuertes and Rudolph Hering called forth by an editorial on this subject, published in this paper on Nov. 11, with editorial replies. 2800 w. Eng News—Nov. 25, 1897. No. 16842.

The Disposal of Garbage and Refuse. Rudolph Hering. An account of the cost of construction and operation of the Berlin, Germany, works. Ill. 3300 w. Eng Rec—Nov. 20, 1897. Serial. 1st part. No. 16725.

The Unsatisfactory Condition of Garbage Disposal in America. Editorial comment with criticism of the paper of Rudolph Hering, published in this journal on Nov. 4, 1897. 1200 w. Eng News—Nov. 11, 1897. No. 16573.

Healthful Construction.

See Architecture and Building, Construction and Design.

Hot Water.

Waste Heat Used. Describes an invention for heating water for public consumption. Utilizes the heat of street gas-lamps. Ill. 1800 w. Dom Engng—Nov., 1897. No. 16705 C.

Illuminants.

The Cost of Various Illuminants at Rouen in France. O. Piequet. Translated from the *Bulletin de la Société Industrielle de Rouen.* A résumé of data in this vicinity with notes relative to each method. 1800 w. Pro Age—Nov. 1, 1897. No. 16309.

Municipal Improvements.

General Taxation and Special Assessment for Municipal Improvements. N. P. Lewis. A consideration of the means of securing the money to pay for improvements, and whether they pay. 2500 w. Munic Engng—Nov., 1897. No. 16302 C.

Quarantine.

The Quarantine System of the United States. Walter Wyman. Describes the system showing the conditions which render it necessary, and explaining the regulations. 3800 w. San—Nov., 1897. No. 16577 D.

The Relation of Federal to State Quarantine. R. M. Swearingen. Read at conference of State Boards of Health, Nashville, Tenn., Aug. 18, 1897, and reprinted from the *Texas Medical Journal.* Reviews the law enacted in 1893, showing its defects. 2800 w. San—Nov., 1897. No. 16578 D.

Utility of Quarantines as Now Conducted—Inspection, Disinfection and Isolation Stations. F. Montizambert. Discussion at the meeting of the British Medical Assn., Montreal, concerning the points in which the regulations and usage of Canada differ from England. 1800 w. San —Nov., 1897. No. 16576 D.

Recreation Pier.

See Civil Engineering, Miscellany.

Transportation.

Plans for Increasing Transportation Facilities in and about New York; East River Transit. A discussion of the projects to bridge or tunnel the North and East Rivers, with information of the present standing of each scheme. Ill. 3400 w. Eng News—Nov. 18, 1897. No. 16709.

Waste.

The Disposal of Muncipal Waste. W. F. Morse. Gives an outline of methods and apparatus and some of the results. 3800 w. Pro. Age—Nov. 15, 1897. No. 16670.

RAILROAD AFFAIRS.

NEW CONSTRUCTION.

Africa.

Rhodesia and Its Railways. Interesting particulars of railway construction, the work of eighteen months covering a distance of 580 miles. 3300 w. Engng—Oct. 22, 1897. No. 16275 A.

Central America.

Central American Railway Enterprises. Brief account of the proposed transcontinental lines in Guatemala, Honduras, San Salvador, Nicaragua, and Costa Rica. 1800 w. Ry Age—Nov. 19, 1897. No. 16790.

China.

A Modern Railroad System for China. S. P. Butler. Interesting account of Sheng Ta-Jen and his influence in railway matters. 3300 w. Harper's Wk—Nov. 27, 1897. No. 16797.

Electricity.

Engineering Side of the Application of Electricity to Standard Railroading. A topical discussion of this subject. 4000 w. N. Y. R R Club—Oct. 21, 1897. No. 16590 D.

Gage.

The Relative Cost of Narrow and Standard Gage Railroads. Letter from M. N. Forney in

reply to inquiry regarding first cost. Thinks there would be no difference if the rolling-stock was of the same character in each. 1800 w. Am Eng & R R Jour—Nov., 1897. No. 16238 C.

Japan.

Japanese Railways. Information on important points, obtained from official sources. Map. 1200 w. Engng—Oct. 29, 1897. No. 16389 A.

Klondike.

See Mining and Metallurgy, Gold and Silver.

Long Island Railroad.

The Electrical Equipment of the Suburban Service of the Long Island Railroad System. Illustrated description of the changes to be made by this road, and the equipment of a considerable part with electric traction apparatus. 1500 w. Elec Wld—Nov. 20, 1897. No. 16672.

Trans-Siberian Railway.

The Manchurian Extension of the Trans-Siberian Railway. Map with explanation, showing the advantage to Russia of this new location which carries this railway across Manchuria to Vladivostock. 600 w. Eng News—Nov. 11, 1897. No. 16569.

MAINTENANCE OF EQUIPMENT.

Brakes.

The Effect of Brakebeam Hanging Upon Brake Efficiency. R. A. Parke. Extracts from a paper presented at meeting of the New York Railroad Club. A careful study of the subject concluding that high efficiency of brakes can only be attained by suspending the brakebeams from the truck frame and between the wheels. 6000 w. R R Gaz—Nov. 19, 1897. No. 16695.

The Emergency Brake and the Garrison Accident. Editorial on the great saving of life due to the action of the emergency brakes. 700 w. R R Gaz—Nov. 19, 1897. No. 16697.

The Sargent Brakeshoe Tests at Wilmerding. Report of extensive road and laboratory tests of the new "Diamond S" brakeshoe. 2200 w. R R Gaz—Nov. 26, 1897. No. 16854.

Two Recent Improvements in Railway-Train Brake-Construction. The improvements discussed are the adaptation of the brakeshoe pressure to each truck, as described by R. A. Parke in a paper read before the N. Y. Railroad Club, and the improvement in construction as shown in the tests of the "Diamond S" brakeshoe. 1400 w. Eng News—Nov. 25, 1897. No. 16844.

Freight Trains.

Handling Freight Trains Partially Equipped with Air. Editorial discussion of paper of Mr. Nichols on this subject, read before the Central Assn. of R. R. Officers, at their July meeting. 2000 w. R R Gaz—Nov. 19, 1897. No. 16696.

Locomotives.

An Articulated Locomotive. Illustrated detailed description. The system is the invention of Mr. Haggans, and the locomotives constructed by M. F. Weidknecht, of Paris, are intended for use on light railways, on which steep gradients and very sharp turns have to be encountered. 700 w. Engr, Lond—Oct. 22, 1897. No. 16270 A.

Heavy Freight Locomotives—Buffalo, Rochester and Pittsburg Railway. Illustration, elevation and sections with descriptive specifications. 600 w. Ry Rev—Oct. 30, 1897. No. 16311.

Mineral Engine, Great Western Railway, England. An illustrated description of the most powerful goods engine working south of the Thames, with dimensions. 800 w. Engr, Lond—Nov. 5, 1897. No. 16643 A.

South-Eastern Railway Locomotives. A. E. Kyffin. Describes some of the older types of the various locomotives which came into the possession of this English road. Ill. 900 w. Mech Wld—Nov. 12, 1897. Serial. 1st part. No. 16768 A.

Steam-Pressure, Throttling and Expansion. Editorial discussion with suggestions as to superheating by use of higher steam-pressures. 1700 w. Am Eng & R R Jour—Nov., 1897. No. 16240 C.

Test of a Four-Cylinder Compound Locomotive—Eastern Railroad of France. M. Salomon, in the *Revue Générale de Chemins des Fer*. Descriptions of the tests, and of the engines tested. 1800 w. R R Gaz—Nov. 12, 1897. No. 16585.

The American Locomotive at Home and Abroad. Editorial on the growing export trade in locomotives, with criticism of an article which appeared in London *Engineering*. 1300 w. Ry Rev—Nov. 13, 1897. No. 16657.

The Locomotives Exhibited at the Second Bavarian Exposition in Nuremberg, 1896. A brief description of the eight locomotives exhibited, taken from a pamphlet on the subject by Eugene Brückmann. 2300 w. R R Gaz—Nov. 26, 1897. No. 16855.

Motor Car.

Steam Motor Car; New England Railroad. Illustrated description of a composite car the operation of which is being watched as an interesting experiment. 600 w. R R Car Jour—Nov., 1897. No. 16564.

The Patton Motor Car. Illustrated description with brief history and editorial. 3500 w. Ry Rev—Nov. 13, 1897. No. 16656.

Private Cars.

A Presidential Train. Illustrated description of handsome equipment built by the Pullman Company for the president of Mexico. 1300 w. Ry Age—Nov. 5, 1897. No. 16501.

President Diaz's Private Cars. Duane Doty. Illustrated detailed description of the fine cars recently built by the Pullman Co. for the Government of Mexico. 2800 w. R R Car Jour—Nov., 1897. No. 16563.

Sanitation.

The Sanitary Aspect of Railway Travelling and Rolling Stock. T. F. Strutt. Read at the Belgian Conference of Sanitary Inspectors. Criticizes the accommodations of local trains in England, and other conditions needing attention. 1700 w. Plumb & Dec—Nov. 1, 1897. No. 16658 A.

Weight Distribution.

The Distribution of Weight in Locomotives. (Die Gewichts-Vertheilung bei Lokomotiven.) An analysis of the distribution of weights upon drivers for various arrangements of axles, and discussion of best disposition of equalizing levers; by Inspector Leitzmann. 7000 w. Glaser's Annalen—Nov. 1, 1897. No. 16442 D.

MAINTENANCE OF WAY.

Dynamometer Car.

Car for Determination of the Resistance to Hauling. (Wagen zur Bestimmung der Widerstände bei Streckenförderungen.) An illustrated description of a dynamometer car used at Lens, Belgium. The pull on the draw bar is automatically registered upon a paper drum. 1000 w. 1 plate. Glückauf—Oct. 16, 1897. No. 16481 B.

Embankments.

The Sliding Embankments of the Hudson River Shore Lines. Archibald A. Schenck. Shows the limited extent and number of difficult places on the Hudson River lines, and explains the care taken in the construction. Ill. 1300 w. Sci Am—Nov. 13, 1897. No. 16558.

Frogs.

The Coughlin Swing-Rail Frog. Gives description with letter from C. O. Vandevanter, of the Western Maryland R. R., and illustrations. 1200 w. Eng News—Nov. 18, 1897. No. 16706.

Rails.

Welded Rails. (Les Rails Soudés.) Ch. E. Guillaume. An investigation of the effects of expansion and contraction upon continuous lengths of rails with solid welded joints. 2000 w. Moniteur Industriel—Sept. 25, 1897. No. 16493 F.

Railway Bridges.

See Civil Engineering, Bridges.

Station.

Columbus Union Passenger Station. Brief illustrated description. 400 w. R R Gaz—Nov. 12, 1897. No. 16588.

Superstructure.

Recent Investigations in Railway Superstructure Construction. (Neuere Versuche mit Oberbau-Constructionen.) An account by Prof. Birk, of experiments with various kinds of ballast, including the influence of frost, travel, material and other conditions. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 15, 1896. No. 16409 B.

Switch.

Switches with Unbroken Main Line Track for Siding Connections. (Weiche mit Ununterbrochenem Hauptgeleise für Abzweigung von Industriebahnen.) Describing several forms of switches by means of which railway siding connections may be made without interrupting the continuity of the main line rails. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 5, 1897. No. 16413 B.

Tracks.

Double-Track Construction. H. R. Safford. Describes a difficult piece of road to operate on the Illinois Central R. R. and the construction of a second track to improve the conditions. 2500 w. Pro of Purdue Soc of Civ Engs—1897. No. 16812 D.

SIGNALING.

Block Signals.

Automatic Block Signals on the Cincinnati, New Orleans & Texas Pacific. Illustrations and description. 1400 w. R R Gaz—Nov. 12, 1897. No. 16586.

Colored Signals.

Colors for Night Fixed Signals. Editorial on this subject from the point of view of the men who use the signals. 1800 w. R R Gaz—Nov. 26, 1897. No. 16858.

TERMINALS AND YARDS.

Railroad Shops.

Erecting Shop, Mt. Clare—Baltimore and Ohio Railroad. Illustrated description. 2000 w. Am Eng & R R Jour—Nov., 1897. No. 16237 C.

New Railroad Shops. Brief illustrated description of the plant of the Georgia and Alabama Railway at Americus, Ga. 800 w. Ry Age—Nov. 5, 1897. No. 16500.

Turn-tables.

An Arrangement for Increasing the Available Diameter of Turn-Tables. From the *Revue Générale des Chemins de Fer.* Description of an arrangement used by the Eastern Railroad of France for increasing the available diameter of their turn-tables. Ill. 600 w. R R Gaz—Nov. 26, 1897. No. 16857.

Three Examples of Recent Practice in Locomotive Turn-table Construction. Describes the hydraulic center-bearing table on the Chicago, Milwaukee and St. Paul Ry., recent practice on the Lehigh Valley Ry., and a pitless turn-table built by the Toledo Foundry & Machine Co. 2500 w. Eng News—Nov. 18, 1897. No. 16710.

TRANSPORTATION.

Accident.

Concerning the Latest Great Railroad Accident. H. G. Prout. Some remarks on the proper meaning of the word "accident," with a few comments on the accident near Garrisons, on the New York Central. 1200 w. Harper's Wk—Nov. 6, 1897. No. 16317.

Competition.

The New Problem in Transportation. Editorial discussion of electric-railroad competition for steam-railroad business. 1700 w. Am Eng & R R Jour—Nov., 1897. No. 16239 C.

Differentials.

Differential Rates and the Seaboard Air Line. T. J. Anderson. A letter to the editor explaining the grounds on which this company claims that it is entitled to differential passenger rates, with editorial. 2000 w. Ry Age—Nov. 12, 1897. No. 16623.

Earnings.

Railroad Earnings Showing Smaller Gains. Explains why the earnings for October in the United States, did not exhibit as large a gain over last year as preceding months showed, and gives tabulated statements of increases and decreases for past three years. 1600 w. Bradstreet's—Nov. 13, 1897. No. 16633.

Heavy Increases in Net Railway Earnings. Tabulated statements showing the improved operations during the third quarter of the year, with comments. 1500 w. Bradstreet's—Nov. 20, 1897. No. 16714.

Interstate Commerce.

See Economics and Industry, Governmental Control.

New York Stations.

Trains in and out of New York Terminal Stations. An interesting summary of the number of trains daily, on the various roads. 450 w. R R Gaz—Nov. 26, 1897. No. 16856.

Passenger Traffic.

Abuses of the Passenger Department. D. B. Martin. Address delivered at meeting of the General Passenger and Ticket Agents in St. Louis. 1300 w. Ry Age—Nov. 19, 1897. No. 16789.

Pooling.

Railway Pooling. George R. Blanchard. Considers the subject under eleven headings covering most of the phases. 3700 w. Ry Mag—Oct., 1897. No. 16604 C.

Railway Situation.

The Present Railway Situation. H. T. Newcomb. Gives a summary of the situation and enumerates some of the changes which the writer believes necessary to a satisfactory solution of the problem in America. 3300 w. N Am Rev—Nov., 1897. No. 16298 D.

Space Interval.

The Space Interval on a Single Track Railroad. Describes the method of working on the Cincinnati division of the Chesapeake & Ohio R. R., with graphical transcript of train sheet. 500 w. R R Gaz—Nov. 26, 1897. No. 16853.

Speed.

Continental Express Speeds and Accommodation. J. Pearson Pattinson. Part first refers to the Belgian state railroads. The information relating to gradients, locomotives, and the statistics of express speed are all taken from official sources and may therefore be deemed accurate. 1800 w. R R Gaz—Nov. 5, 1897. Serial. 1st part. No. 16372.

The Swiftest Trains of Europe. (Die Schnellsten Züge Europas.) A brief introduction, followed by a table of the fastest trains of the principal countries of Continental Europe, giving total length of run, time of run, maximum speed, and time consumed by stops. 1500 w. Glaser's Annalen—Oct. 15, 1897. No. 16439 D.

Suburban Railroads.

Electricity on Steam Suburban Railroads. S. H. Short. Reviewing briefly some of the features of the paper by N. H. Heft, read before the Am. St. Ry. Assn., with editorial. 2400 w. Elec Eng, N. Y.—Oct. 28, 1897. No. 16234.

Train Service.

The Past Summer Train Services. Editorial comment on the English and Scotch train service of the past season. 1800 w. Engng—Oct. 22, 1897. No. 16277 A.

Transportation.

Plans for Extending Transportation Facilities in and About New York—North River Transit. Presents the schemes under discussion for crossing the North River and the cause of their being thus far unable to secure the necessary capital. 3300 w. Eng News—Nov. 25, 1897. No. 16841.

MISCELLANY.

Address.

The Railways of America. M. E. Ingalls. An address delivered at Purdue University reviewing what the railroads have done for the nation, what they are, and what reforms are needed. 3500 w. Ry Age—Nov. 26, 1897. No. 16885.

China.

China and Her Railways. Perry F. Nursey. Information relating to past commercial enterprises, and the cause of their failure, with account of the efforts to introduce railways. 2300 w. Ind & Ir—Nov. 5, 1897. No. 16612 A.

The Chinese Railway Contracts. J. T. M. Information concerning terms of the famous Belgian contract which is said to have been rejected, and of Sheng Senn Wy, the Director-General of Railways. 3000 w. Ry Age—Nov. 26, 1897. No. 16884.

Electricity.

Application of Electricity to Railroads Now Operated by Steam Power. N. H. Heft. Full paper, with discussion, as presented before the American Street Railway Assn. The experience of the New York, New Haven and Hartford R. R. Co., giving results and conclusions that have been reached as to the best methods of applying electricity to heavy railroad work. 5600 w. St Ry Rev—Nov. 15, 1897. No. 16584 C.

European Railways.

Their Trains and Ours. Robert P. Porter. From *Boston Transcript*. Experiences of an American on European railways. 2000 w. Ry Rev—Nov. 20, 1897. No. 16767.

Employes.

Discipline of Employes. George H. Davis. Discussion of this subject with suggestions. Read before the American Street Railway Assn. 4400 w. St Ry Rev—Nov. 15, 1897. No. 16583 C.

Great Britain.

Railways and Railwaymen. Editorial discussion of the demands made by the Amalgamated Society of Railway Servants. 1300 w. Engr, Lond—Oct. 29, 1897. No. 16513 A.

Interstate Commerce.

Report of the Interstate Commerce Commission. Interesting information taken from this

report with editorial comment. 800 w. Sci Am—Nov. 13, 1897. No. 16556.

Labor.

See Economics and Industry, Labor.

Metropolitan Railway.

The Ventilation of the Underground. Comments on the evidence given in the report of the Board of Trade of London, discussing the advisability of substituting electricity as a motive power, means of ventilation, &c. 3500 w. Trans—Oct. 29, 1897. No. 16398 A.

Narrow Gauge.

Narrow Gauge Steam Timber Roads in Galicia. (Ueber Schmalspurige Waldbahnen mit Dampfbetrieb in Galizien.) A. R. Fleischl. General description of a system of roads of 800 mm. gauge in the forests of Galicia, with topographical maps, profiles and details of rolling stock. Six plates, 7500 w. Mitt d Ver f d Förd d Local u Strassenbahnwesens—Aug., 1897. No. 16486 E.

The Wallücke Railway. (Die Wallückebahn.) Illustrated description of an 18 mile, 24 in. gauge steam road in Rhenish Prussia, with details of track and rolling stock. The road is mainly used for the transportation of iron ore. Three articles. 10,000 w. Die Schmalspurbahn —Oct. 1, 16, Nov. 1. 1897. No. 16490 H.

Ohio.

Pioneer Railroad of Ohio. Clark Waggoner. Interesting facts connected with the early history of railroading in this state. 1400 w. R R Gaz—Nov. 12, 1897. No. 16587.

Pacific Railroads.

The Pacific Railroads. Reviews the construction of the five roads extending to the Pacific, the competition, and the causes that have made their operation difficult. 1700 w. Engng —Nov. 5, 1897. No. 16619 A.

Prussia.

The Administration of Prussian Railroads. B. H. Meyer. A discussion of the Prussian system, with special reference to the adjustment of railway rates. 12000 w. An Am Acad—Nov., 1897. No. 16686 G.

Railways.

American Railways. Abstract of ninth statistical report of the interstate commerce commission, giving the estimated value of American railways as over $10,000,000,000. 1600 w. Bos Jour of Com—Oct. 30, 1897. No. 16243.

Railway Plans.

The Preparation of Parliamentary Plans for Railways. Harnett John Fuller. The aim of the author is to explain those methods which he has found to minimize errors. 2400 w. Engr, Lond—Nov. 5, 1897. Serial, 1st part. No. 16641 A.

Resistance.

Train Resistance. Editorial discussion of this subject, with suggestions for further investigations. 2200 w. Engr, Lond.—Oct. 22, 1897. No. 16271 A.

Secondary Roads.

The Utility of Secondary Roads. (Die Nützlichkeit der Secundärbahnen.) A thorough discussion of the commercial value of "feeder," or secondary roads operated in connection with main lines. 10000 w. Mitt d Ver f d Förd d Local u Strassenbahnwesens—Sept., 1897. No. 16487 E.

Venezuela.

Railroad Laws in Venezuela. A translation of the new law on railroad construction, which grants subsidies and other favorable concessions. 2800 w. Cons Repts—Nov., 1897. No. 16522 D.

STREET AND ELECTRIC TRAMWAYS.

Accumulator Traction.

Accumulator Traction in Cologne. C. H. Biggs, Jr. Information relating to the proposed change of power on what is said to be the best paying line in Germany. 1000 w. Elec Eng, Lond—Oct. 29, 1897. No. 16525 A.

Accumulator Traction on Rails and Ordinary Roads. L. Epstein. Part first reviews the causes that have delayed success in this field, and gives data concerning the system as applied at various places. 2000 w. Elec Eng, Lond—Nov. 12, 1897. Serial. 1st part. No. 16740 A.

Application of the Storage Battery to Electric Traction. Charles Hewitt. Read before the American Street Railway Assn. The full paper with discussion. Discusses the application of the battery direct to car or locomotive, to the ends of long lines, and to the power-house. Ill. 8000 w. St Ry Rev—Nov. 15, 1897. No. 16582 C.

Air Motors.

See same title under Mechanical Engineering, Compressed Air.

Basle.

The Basle Electric Tramway. Illustrated description of the electric tramway connecting the two railway stations in this city of Switzerland, and the difficulties arising from the narrow streets. 1200 w. Ry Wld—Nov., 1897. No. 16611 A.

Bridge Cars.

The Plans for Running Through Cars Over the Brooklyn Bridge. Plans showing final arrangements adopted, with explanation. 1000 w. Eng News—Nov. 18, 1897. No. 16707.

Budapest.

The Electric Railways of Budapest. (Die Elektrische Stadtbahnen zu Budapest.) A very full account of the surface and underground electric railways of Budapest, including photographs of power houses and portions of the subway. 7500 w. Elektrotechnische Zeitschr—Sept. 9, 1897. No. 16461 B.

The Francis-Joseph Electric Underground Railway at Budapest. (Die Budapester Elektrische Franz-Josef Untergrundbahn.) With

plan of the lines and photographic views, together with sections of tunnel. 4500 w. Mitt d Ver f d Ford d Local u Strassenbahnwesens. —Sept., 1897. No. 16488 E.

Difficulties.

Some of the Difficulties Existing in the Construction and Operation of Electric Street Railways. G. W. Knox. Read before the American Street Railway Assn. The opportunities for economy in construction and operation are discussed. 4400 w. St Ry Rev—Nov. 15, 1897. No. 16581 C.

Edinburgh.

The Progress of Cable Construction in Edinburgh. Points brought into view during the conversion of the tramways to the cable system. Ill. 3300 w. Ry Wld—Nov., 1897. No. 16610 A.

Electricity.

See Railroad Affairs, Miscellany.

Electric Locomotive.

See Mining and Metallurgy, Mining.

Electric Traction.

Mechanical Features of Electric Traction. Philip Dawson. Portion of a paper read before the Institution of Mechanical Engineers, England, considering poles, insulators, trucks, motors, gearing, power, &c. 2800 w. Engr, Lond—Nov. 12, 1897. No. 16733 A.

Generators.

Some Features of Modern Electric Railway and Power Generators. Views of several generators of recent design, representing the best American practice, are given, with information concerning them. 2500 w. Eng News—Nov. 25, 1897. No. 16840.

Haulage.

See Mechanical Engineering, Power and Transmission.

History.

The Progress of Electricity on Railways During the Past Twenty-Five Years. W. Langdon. The progress traced is confined to work in Great Britain. Considers construction, materials, accessories, and applications. 4500 w. Elec Rev, Lond—Nov. 12, 1897. No. 16752 A.

Twenty-Five Years of Electric Traction. Philip Dawson. History of the development and progress. 3000 w. Elec Rev, Lond—Nov. 12, 1897. No. 16758 A.

Manchester, England.

See Electrical Engineering, Lighting.

Monorail.

The Portable Monorail Surface Road. (Le Monorail Portatif à Niveau du Sol.) Description of the Caillet system of one-rail portable railway for temporary agricultural and exploration service, with many illustrations of practical applications. 2500 w. 1 plate. La Revue Technique—Nov. 10, 1897. No. 16430 D.

Motor Car.

See Electrical Engineering, Power.

Mountain Road.

The Salève Electric Railway. (Chemins de Fer Electriques du Salève.) Description of a new third-rail electric rack railway from Veyrier to Treize Arbres, in Savoy. The road is about 4½ miles long, with a maximum grade of 25 in 100; the current is generated by water power. 2500 w. 1 plate. La Revue Technique. Oct. 25, 1897. No. 16429 D.

The Street and Mountain Tramway between Linz, Urfahr, and Pöstlingberg. (Die Strassen- und Bergbahn Linz-Urfahr-Pöstlingberg.) Illustrated description of this Austrian electric mountain tramway. The ascent is made by adhesion, with a uniform grade of 10 per cent. Map and profile. Two articles. 2500 w. Die Schmalspurbahn—Oct. 1, 16, 1897. No. 16489 G.

Municipal Ownership.

Municipal Ownership and Operation of Street Railways. P. F. Sullivan. Full paper as read at the Niagara Falls convention of the American Street Railway Assn. Unfavorable to its adoption in American cities at present. 7500 w. St Ry Rev—Nov. 15, 1897. No. 16580 D.

Norway.

The Electric Tramway of Bergen. (Die Elektrische Strassenbahn der Stadt Bergen.) An interesting description, with photographs, of the overhead trolley line at Bergen; the second electric road started in Norway. 2500 w. Die Schmal spurbahn—Nov. 1, 1897—Nov. 1, 1897—No. 16491 D.

Rapid Construction.

Construcotin of 2½ Miles of Electric Railroad Complete in 22 Hours. Describes the rapid work in building the road between Bound Brook and Somerville, N. J., by the New York and Philadelphia Traction Company. Ill. 2200 w. Elec Eng, N. Y.—Nov. 4, 1897. No, 16331.

Rapid Transit.

New York Rapid Transit Outlook. Considers the report of the Rapid Transit Commissioners favoring the building of the road, and the prospect of the work being undertaken in the near future. 1100 w. Eng Rec—Nov. 13, 1897. No. 16637.

Regulation.

A New Method of Regulation for Tramway Motors. (Ueber eine Neue Regulirung für Bahn motoren.) Prof. Blondel. The system consists in a combination of two electro motors with a storage battery and a special form of series parallel regulator. 3000 w. Elektrictechnische Zeitschr—Oct. 28, 1897. No. 16468 B.

Rights.

The Massachusetts Theory of Street Railway Rights and Privileges. From the *N. Y. Evening Post.* Discussion of the principle which should govern legislation regarding street railways, as stated by Charles Francis Adams, chairman of the committee of investigation in the part of the State. 1400 w. Elec Eng, N. Y.—Nov. 25, 1897. No. 16850.

Suburban Railroads.

See Railroad Affairs, Transportation.

Transportation.

See Municipal Engineering, Miscellany.

BOOKS OF THE MONTH

LE MÉCANISME DU LIT FLUVIAL. Par V. Lokhtine, ingénieur des voies de communication. St. Petersbourg: Bureau Technique International, 1897.

M. Lokhtine, who is the director of roads and navigable waterways in the government of Kazan, has prepared this essay to discuss the nature, from a mechanical standpoint, of rivers considered in their entirety. As he rightly says, in existing treatises we look in vain for a discussion of the general physical properties of a river, finding, instead, a treatment of particular cases, each different from every other. When, for example, we desire to examine why one portion of a stream has a deep and permanent bed, while another has always an uncertain and shifting bottom, we find no investigations to aid us, although there must be some law governing the mechanical actions at work. It is to the solution of these problems that this eminent Russian specialist has devoted himself, and to hydraulic engineers especially his work will be found a valuable contribution to engineering physics.

The author considers the course of every river to be based upon three fundamental factors: 1, the volume of flow, depending upon climatic conditions, and upon the nature of the country traversed; 2, the slope, governed by the general relief of the area through which the river flows; 3, the nature of the material of the river-bed, considered in view of its greater or less destructibility under the action of the water.

These three factors determine completely the character of a river, and give the characteristic properties which distinguish it from other streams; and it is upon these, as a foundation, that M. Lokhtine bases his discussion.

The data used in the work are naturally obtained mainly from observations upon the rivers of Russia, including the Volga, Dnieper, Don, Vistula, Niemen, Dwina, and others, and the observations of Baumgarten on the Garonne and the Lot are also included. The questions of stable and unstable equilibrium, so to speak, of a river-bed are shown to depend upon the relative preponderance of slope to resistance of material, and these again are modified in times of high or low water. While the data at present collected are hardly in shape to permit of reduction to mathematical form, the obedience of the forces to law is shown and sustained.

Profiles of portions of the Volga are given, and plans of certain of its shallows, together with maps showing the changes in the bed of the Amon-Daria at the point where it is crossed by the Trans-Caspian railway.

While the subject is far too vast to be exhausted in such a work as this, M. Lokhtine has approached it in the true scientific spirit, and broken the way for others.

THE ELEMENTS OF ELECTRO-CHEMISTRY Treated Experimentally. By Dr. Robert Lüpke. Translated from the second revised and enlarged edition, by M. M. Pattison Muir, M. A. London: H. Grevel & Co., Philadelphia: J. B. Lippincott Co. 1897. Cloth.

Notwithstanding the long time which has elapsed since the art of electroplating has been practised, the development of the general science of electro-chemistry has by no means kept pace with the progress of electrical science in general, and it is only within a few years, that electro-chemistry has begun to receive the attention which its importance demands.

The greatest development of the science has taken place in Germany, and it is from Germany that the best treatises on the subject must come, at least for the present. Although the efforts of the leading students of the science have been largely devoted to the establishment of the theoretical principles of electro-chemistry, it is upon experimental investigations that this work must be based, and Dr. Lüpke's work, as its title indicates, discusses the experimental side of the questions very fully.

The work is divided into three parts, of which the first is devoted to recent the-

ories of electrolysis, the second discusses van't Hoff's theory of solutions, and the third treats of the osmotic theory of the current of galvanic cells.

In the first section the work of Hittorf, Kohlrausch, Arrhenius, Ostwald, Grotthus, and others is treated; and such subjects as the motions of the ions, and the theory of transport numbers as discovered by Hittorf, and the dissociation theory of Arrhenius, are discussed in a manner until now not accessible to English students.

There is no doubt that this entire subject of electro-chemistry is destined to play a most important part both in the researches of pure science and in the technical applications to the arts, and, in view of the meagre information until now accessible in the English, this translation of Dr. Lüpke's standard work is especially acceptable.

The work of translation appears to be well done, and the book is well printed and illustrated.

AMERICAN AND OTHER MACHINERY ABROAD. Being a study of the European field for the introduction of American machinery. By Fred J. Miller. New York. American Machinist, 1897. Flexible linen.

This reprint of Mr. Miller's letters to the *American Machinist* forms very interesting reading, not only from the fact that it gives much information to builders of American machinery about the conditions which tools for use in other countries must meet, but also because it is written in a bright and entertaining manner, about many things which the general traveller utterly fails to observe.

Some of the points made by Mr. Miller as to the ways and methods of English workmen are instructive reading, in view of the contest of the A. S. E., which, although not on when the book was written, includes some of the questions that strike the eye of an American immediately.

There is little doubt that one of the greatest obstacles which American tools are to meet in England is the opposition of the workmen to the so-called "intensive" methods of production, and it will surely be very difficult for the employers to get the output from the American tools which they were constructed to furnish. The opposition of the men to tools which enable one man to do the work of ten without actually laboring any harder, or which turn out better work with an unskilled attendant than the most experienced machinist could do, will be a very difficult thing to overcome.

The writer wishes, in justice to English administrative methods, to compare his own experience at Woolwich arsenal with that of Mr. Miller. Although a parliamentary inquiry was impending about some special work, one English friend introduced three Americans, who, indeed, were detained a few minutes upon their announcement of nationality, but, after they had registered and stated officially that nothing would be published which might be seen, were passed into the arsenal without more than five minutes' delay.

Mr. Miller spent some time in continental Europe, going as far as Russia, but for this and much other interesting matter we must refer all who are interested in the subject of American machinery abroad to the full perusal of his entertaining little book.

LETTERING FOR DRAFTSMEN, ENGINEERS, AND STUDENTS. By Charles W. Reinhardt. Third Revised Edition. New York: D. Van Nostrand Company, 1897. Oblong boards.

The art of constructing elaborately-lettered titles for engineering and mechanical drawings bids fair to become one of the lost arts, and one to which we can bid farewell most cheerfully, sending it to keep company with the classic or gothic architecture which formerly played so important a part in machine frame-work, or with the beautiful brush-work which shaded the swelling contours of many of the elaborate drawings of a past generation. Even for working drawings, the plain block letter which every draftsman should know how to make is becoming less necessary, since in most well-regulated drawing-rooms in the United States at least the titles are now appended by some of the mechanical printing processes of recent introduction, at the same time saving the draftsman's labor and furnishing occupation for the office-boy.

Mr. Reinhardt's book, however, is

mainly for another line of work, and one which is by no means so likely to be superseded, since the greater portion of his work is devoted to the art of making neat and legible inscriptions upon the drawings themselves. In this line the author has had much experience, as the draftsman for *Engineering News*, and, as a consequence, his work is especially adapted for use in connection with the lettering and figuring upon drawings intended for reproduction and illustration. For this, the book is certainly to be recommended, and we must say that there is infinitely more style and effect in the neat outline system so well shown and explained in this system than in the German "*Rundschrift*" which has found vogue in some quarters.

The fact that the work has reached its third thousand is ample evidence that it is meeting with popular appreciation.

PHYSICAL PROBLEMS AND THEIR SOLUTION. By A. Bourgougnon. New York, D. Van Nostrand Co. 1897. Boards, 50 cents.

This latest addition to Van Nostrand's Science Series contains a number of worked-out problems in elementary physics, evidently intended to supplement the shortcomings of the usual text-books of physics.

Practical examples in mechanics, hydrostatics, pneumatics, acoustics, and heat are given, and a few problems in electricity, while an appendix includes a set of problems given at examinations by the University of the State of New York.

BOOKS RECEIVED.

The Elementary Principles of Machine Design. By J. G. A. Meyer. New York: The Industrial Publication Co.

Ninth Special Report of the Commissioner of Labor. The Italians in Chicago. A Social and Economical Study. Prepared under the direction of Carroll D. Wright, commissioner of labor. Washington, U. S. A.: Government Printing Office.

How to Build a Home. The House Practical. Being suggestions as to safety from fire, safety to health, convenience, durability, and economy. By Francis C. Moore. New York: Doubleday & McClure Co.

Le Mécanisme du Lit Fluvial. Par V. Lokhtine, ingénieur des voies de communication. St. Pétersbourg: Bureau Technique International.

Report of Paving-Brick Commission. National Brick Manufacturers' Association of the United States of America. Standard Paving-Brick Tests, and Methods for their Conduct. Published for the Association by T. A. Randall & Co., Indianapolis, Ind., U. S. A.

The Architects' Directory for 1897–98. New York: William T. Comstock.

The Essentials of Gearing. A Text-Book for Technical Students and for Self-Instruction. By Gardner C. Anthony. Boston, Mass., U. S. A.: D. C. Heath & Co. Cloth, $1.50.

The Elements of Electro-Chemistry. Treated Experimentally. By Dr. Robert Lüpke. Translated by M. M. Pattison Muir, M. A. London: H. Grevel & Co. Philadelphia, Pa., U. S. A.: J. B. Lippincott Co. $2.50.

Physical Problems and Their Solutions. By A. Bourgougnon. New York: D. Van Nostrand Co. 50 cents.

Euclid: Books I–IV. By Rupert Deakin, M. A. University Tutorial Series: London: W. B. Clive; New York: Hinds & Noble. The Tutorial Trigonometry. By William Briggs, M. A.; F. C. S., F. R. A. S., and G. H. Bryan, Sc. D., F. R. S. The University Tutorial Series. London: W. B. Clive; New York: Hinds & Noble.

American and Other Machinery Abroad. Being a Study of the European Field for the Introduction of American Machinery. By Fred. J. Miller. New York: American Machinist.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Matthews & Yates, Ltd., Cyclone Works, Swinton, Manchester, England.=Catalogue entitled "Ventilating and Electrical Specialities," containing information of interest to the engineer. It includes dimensions, prices, and other data of the "Swinton" dynamos and motors, wound in series, shunt, or compound; "Cyclone" electric blowers and exhausters, with inlet diameters from 5 inches to 27 inches; and of the "Cyclone" electric fans, 12 to 60 inches diameter. The catalogue is excellently printed and illustrated in half tone.

Spencer & Co., Melksham, Wilts, England.=Catalogue of their methods of loading and handling grain, seed, etc.

James Rigg, 11 Queen Victoria St., London.=A small catalogue of patent machinery for tipping coal.

W. H. Bailey & Co., Albion Works, Salford, England.=New catalogue dealing with steam-engine and boiler fittings, in which almost every conceivable device is illustrated and priced. The catalogue is entitled "Bailey's Useful Inventions for Engineers."

The Sturtevant Engineering Co., 75 Queen Victoria St., London, E. C.=Catalogue No. 14 of the Cutler-Hammer motors, starting-switches and speed regulators. The Cutler-Hammer automatic action in starting-switches has the object of shielding the motor from harm when, through accident or carelessness, the current is interrupted or the motor is overloaded. The catalogue contains illustrations accompanied by short descriptions.

R. W. Paul, 44 Hatton Garden, London, E. C.=Descriptive catalogue with illustrations and prices of a number of resistance boxes, galvanometers, voltmeters, and electrometers.

Armstrong, Stevens & Co., Whitall St., Birmingham, England.=Catalogue showing a large number of different forms of drop forgings and bolts.

The Vauxhall Iron Works Co., Ltd., Wandsworth Rd., London.=Catalogue describing the Dayton pistonoidal slide-valve, which, it is stated, combines the features of the ordinary D valve with those of the piston valve.

G. G. Blackwell, Sons & Co., The Albany, Liverpool, England.=(*a*), Pamphlet dealing with special alloys largely used by steel makers and founders; (*b*), Pamphlet, on "prepared manganese."

Downie & Adams, 24 Newman St., London.=Catalogue giving details of the Brillié meters, recording up to 10,000 watts on the two-wire system, and up to 20,000 watts on the three-wire system.

Messrs. Yates & Thorn, Blackburn, England.=Illustrated catalogue of steam boilers and accessories, compiled by W. H. Fowler, supplemented by articles and explanatory details making it valuable as a source of information. The book has a most complete index and the text is accompanied by 155 figures. The first fifty pages are given up to the principles of steam-boiler construction and evaporative efficiency, the remaining 100 pages to various types of boilers made by Messrs. Yates & Thorn, including the vertical, multitubular and Fairbairn and Elephant types. The catalogue also includes details of boiler-feed pumps, boiler fittings, and bridge and girder work.

Baldwin Locomotive Works, Philadelphia, Pa., U. S. A.=Illustrated catalogue of narrow-gage locomotives, with special reference to the Japanese trade. 450 pages, illustrated by half tone and sectional views. The first part gives a history of the firm, followed by a catalogue of various types of narrow-gage locomotives, accompanied by specifications and instructions for cabling orders. The latter part of the book is almost entirely given up to drawings, details, and code for ordering various parts of locomotives.

Sturtevant Engineering Co., 75, Queen Victoria Street, London, E. C.=Catalogue No. 100, in French, entitled Catalogue Général Illustré des Ventilateures Sturtevant, octavo, paper, 42 pages, well printed and illustrated, and carefully prepared by an engineer acquainted with technical French. This catalogue contains details of the numerous varieties of Sturtevant ventilators, gas exhausters, heaters, etc., of general and special make, also pulleys, registers, etc., adapted to use with the Sturtevant machines.

Walter George Atkins, C. E. 27, Agamemnon Road, West Hampstead, London, N. W.=Circular on "The Modern System of Water Purification, or the Perfection of the Lime Process of Softening," 4 pages.

Bullivant & Co., Ltd., 72, Mark Lane, London, E. C.=Pamphlet. on "Wire Mining- and Hauling-Ropes: Their Construction and Uses, Embracing Aerial Ropeways," by J. Bucknal Smith, C.E., author of "Wire: Its Manufacture and Uses," etc., being an abstract from "The Mining Journal," 1897, large octavo, paper, 32 pages, with a number of full-page and other illustrations of plants constructed by Messrs. Bullivant & Co., Ltd., and of their appliances. The pamphlet treats clearly and interestingly of some historical points in the manufacture of wire and in the employment of wire ropes; of the vexed questions of gages, at least partially settled finally by the establishment of the "standard wire gage," and the millimeter gage; and of the modern methods and results of Messrs. Bullivant & Co., Ltd. It concludes with descriptions of varying Bullivant installations now in operation.

R. White & Sons.=Reprints of articles containing well-illustrated descriptions of light-rail-

ways, with special reference to the system of Messrs. R. White & Sons.

William O'Brien, 21 Ibrox Terrace, Glasgow.=Illustrated circular sheet, containing description of Mr. O'Brien's patented apparatus for closing water-tight doors on ships's bulkheads, automatically or by hand, thus insuring greater security for life at sea.

Worthington Pumping Engine Co., 153 Queen Victoria Street, London.=General catalogue of Worthington pumping machinery, illustrating and describing most excellently a remarkable variety of pumps, and of meters, pump-connections, pressure regulators, marine feed-water heaters and cognate appliances. Among the many new types of pumping-machinery catalogued are to be noted the vertical ballast pump, sinking pump, vertical twin-cylinder air pump, direct-connected electric pump, electric power pump, and steeple pumps. The catalogue is admirably codified and indexed, and gives much serviceable information in formulas, tables of steam- and water-pressures, frictional losses, etc.

R. D. Wood & Co., Philadelphia, Pa., U.S.A.=Illustrated catalogue of hydraulic tools, cranes, and machinery, including valves, intensifiers, shears, punches, rivetters, and lifts. The machinery is much of it illustrated from actual service installations, and represents all types and sizes up to the largest travelling and jib cranes. A supplement contains some illustrated advertisements of gas and waterworks appliances.

James Leffel & Co., Springfield, Ohio, U. S. A.=New catalogue of turbine wheels, extensively and effectively illustrated; the illustrations are almost all taken from actual installations, some of them very large. Besides the description of the Standard, Special, and Samson wheels, and the very full accompanying tables of efficiency and capacity, the catalogue has an unusual amount of information concerning measurement of water-powers, head-pipes, head-gates, penstocks, water-wheel power-connections, power transmission, and other problems connected with the installation and management of water-power.

Merchant & Co., New York, Philadelphia, and Chicago, U. S. A.=Catalogue of Merchant's Spanish tiles and Gothic shingles, made of copper, galvanized iron, zinc, and terne plates. The catalogue is devoted to description of the metal tiles, the mode of laying, illustrations of special forms, and photo-engravings of buildings on which they are in use.

The C. W. Hunt Co., New York.=Catalogue "No. 9710," manila rope for transmission and hoisting. With excellent illustrations of rope manufacture, knots, splices, and rope-drives and driving machinery, as well as transmission diagrams, tables, formulæ, and other data. With its appendices from technical journals, the catalogue, in fact, constitutes a brief treatise for engineers on ropes for transmission of power.

The Contractors' Plant Mfg. Co., Buffalo, N. Y.=Illustrated catalogue, for 1897–98. An excellently-designed book of 140 pages, filled with engravings and descriptive text and data concerning steam-, horse-, and hand-power hoisting machinery—wheels, derricks, blocks, sheaves, contractors' plows, cranes, wire cable and guy-rope, and contractors' supplies. Fully indexed.

Edison & Swan United Electric-Light Co., Ltd., London.=Handsome illustrated covered catalogue of the company's exhibit at the Imperial Victorian Exhibition, Crystal Palace, 1897. Concludes with illustrations and description of lamps in many styles, switches, dynamos, and motors.

The Pratt & Whitney Co., Hartford, Conn., U. S. A.=Descriptive and illustrated catalogue, making a small, stiff-covered book of 400 pages, with engravings, descriptive text, and dimensions of every variety of lathes, boring and drilling machines, milling machines, planers, shapers, and American machine tools of the latest design for all purposes, general and special. In fact, a compendium of American machine-tool practice.

A. S. Gear, New York.=Small illustrated catalogue of hydrants, especially the flush pattern, which is placed beneath the sidewalk. The information is well condensed, and the cuts clearly indicate the construction of the hydrant.

Illinois Steel Co., Chicago, Ill., U. S. A.=(*a*) Small pamphlet devoted to steel portland cement, giving tests of the cement by high authorities, and testimonials from engineers who have used it in important work; (*b*) illustrated folder, presenting similar matter in condensed form.

The New Era Iron Works Co., Dayton, Ohio, U. S. A.=Well-illustrated catalogue of gas and gasoline engines, of various types and sizes.

Thorpe, Platt & Co., New York.=Illustrated folder of Geipel's steam trap, for high- or low-pressure steam, with sectional drawings, and list of sizes and prices.

John W. Hartman, Bethlehem, Pa., U. S. A.=Illustrated folder of the Hartman automatic regulator, for preventing the accumulating of air in pressure pipes.

The Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., U. S. A.=(*a*) Illustrated catalogue (Section E) of foot presses, drop presses, and screw presses. The engravings are good, and the accompanying text and data brief and pointed; (*b*) supplementary folder of portable, bench, and four-poppet drop presses; (*c*) leaflet of hydraulic press and vertical milling-machine.

Boston and Lockport Block Co., Boston, Mass., and Lockport, N. Y.=Handy illustrated catalogue of tackle blocks, sheaves, differential hoists, diaphragm, pumps, warehouse trucks, cant-hooks, jacks, etc.

U. S. Wind Engine & Pump Co., Batavia, Ill., U. S. A.=Handsomely-illustrated catalogue of wind-mills, towers, pumps, artesian-well supplies, and irrigation specialties. Also of power pumps, valves, reducers, fittings, and tools.

The Railroad Supply Co., Chicago, Ill., U. S. A.=(*a*) Illustrated catalogue of "items of interest on ties and tie plates;" engravings of protected and unprotected ties, made from samples in actual service; (*b*) catalogue of the "Chicago" railroad-crossing signal; (*c*) illustrated folder of the anchor tie-plate guard-rail brace.

The Deane Steam-Pump Co., Holyoke, Mass., U. S. A.=Descriptive catalogue of the Deane steam and power pumps and pumping machinery: octavo, 132 pages, in card-board cover, well printed and with superior illustrations. This catalogue provides a telegraphic ordering code, including a code word for every size and capacity of pump manufactured by the company; it has also a chapter of useful information and tables of equivalents of various weights and measures, areas of circles in inches, friction of water in pipes, factors of evaporation, properties of saturated steam, etc.

M. T. Davidson, 45 Keap Street, Brooklyn, N. Y.=(*a*) Illustrated catalogue of steam pumps for all kinds of service—water works, boiler-feeding, mining, fire, tanneries, artesian and deep wells, etc.; also of air and circulating pumps, acid pumps, vacuum pumps, blowing engines, evaporators, packing and accessories. An appendix gives tables of useful data of area, contents of cylinders, pressure of water and steam, and hydrant and hose streams. (*b*) Leaflet of White's cooling tower and evaporative condenser.

The Fellows Gear-Shaper Co., Springfield, Vermont, U. S. A.=Illustrated catalogue on heavy cardboard, stating briefly, but clearly, the merits of a gear-shaper which is said to cut a theoretically-correct tooth.

The Graves Elevator Co., Rochester, N. Y.=Special illustrated catalogue of passenger and freight elevators, of hydraulic, electric, belt- and gear-driven screw types; also of elevator cars and safety appliances.

General Electric Co., Schenectady, N. Y.=Handsomely-illustrated catalogue, entitled "Operation of Electric Mining Plants," and consisting essentially of brief general accounts of actual installations with testimonials from the companies using them.

Manhattan Electrical Supply Co., New York.=Illustrated catalogue of 300 pages, devoted to electric-light, household, telephone and telegraph supplies—batteries, push-buttons, switches, bells, gas-lighters, lamps, brackets, induction coils, and similar apparatus.

Newton Machine-Tool Works, Philadelphia, Pa., U. S. A.=Catalogue "No. 33," 180 pages, illustrated, descriptive of a large line of planing, shaping, drilling, cutting-off, milling, slotting, and other general and special machine-tools.

Electric Appliance Co., Chicago, Ill., U. S. A.=General catalogue No. 6; a large cloth-bound volume of nearly 600 pages, well printed, illustrated, and indexed; the apparatus described and listed includes every variety of appliance for transmission and application of electricity, especially in its lighter uses.

F. J. Collin, Leeds, England.=Circular and leaflet of Collin's patent coke-ovens, with list of installations of this type since 1890.

The Knickerbocker Engine Works, Hartford, Conn., U. S. A.=Illustrated catalogue of the Knickerbocker engine, a horizontal engine of peculiar form occupying very small space. Photo-engravings of sectional drawings and of several types of completed engines are given in connection with the text.

Chas. E. Parker, Orange, Texas, U. S. A.=Descriptive catalogue of the Parker Safety water-tube boiler, illustrated by line cuts of the boiler under construction and completed.

The Philadelphia Bridge Works, Pottstown, Pa, U. S. A.=Illustrated catalogue of deck and half through turntables, with descriptive text, list of duplicate parts, and reference to railways using these turntables.

Richards & Co., New York and Chicago.=Catalogue and price-list of chemicals.

Brentano's, Paris, New York, and Chicago.=Catalogue of new publications and new editions, with mention of German, French, and Italian departments and subscription department for periodicals.